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② nutrition ③ nutrients —
④ vitamins ⑤ mineral
elements ⑥ proteins ⑦ amino
acids ⑧ malnutrition
⑨ foods ⑩ nutritional requi
-rements ⑪ diet planning
⑫ diet ⑬ nutritive value
⑭ heinz products ⑮ food
Composition

NUTRITIONAL DATA

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and

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MELLON INSTITUTE • PITTSBURGH

PENNSYLVANIA

CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE
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FOREWORD

IN PRESENTING this successor to its "Nutritional Charts," H. J. Heinz Company wishes to record its deep appreciation of the splendid and generous expressions on the value of this publication. Developments in the field of nutrition have been truly a miracle of modern science. Each year adds new knowledge. The application of this information to our daily dietary habits is a most important factor in national and world health and security.

The present edition is completely rewritten, brought up to date, and offered in a more convenient form.

We trust that this new effort will be helpful in expanding the knowledge and utilization of nutritional research.

H. J. HEINZ II
President, H. J. Heinz Company

PREFACE

"Since the emperor declined the fame and envy of original composition, we can only require at his hands method, choice, and fidelity, the humble though indispensable virtues of a compiler."

—EDWARD GIBBON

THIS BOOK supersedes "Nutritional Charts for Medical and Other Specialists" published and distributed by H. J. Heinz Company since 1934.

"Nutritional Charts" has had a long and honorable career. Twelve editions and 650,000 copies attest its wide and favorable reception. Most flattering has been its adoption as a teaching aid by a majority of the medical schools of this country. Inevitably the growth of nutritional knowledge has made a thorough and complete revision necessary.

NUTRITIONAL DATA differs from its predecessor in both format and content. A detailed description of changes would be tedious, since this purpose is served by the Table of Contents. The increasing emphasis on proteins is reflected by a new section on this subject. The material on vitamins, essential elements, intermediary metabolism, and many other topics has been re-cast and modernized. Attention is particularly called to the tables on "Composition and Nutritive Value of Foods" which have formed the sturdy and unspectacular backbone of this work since its inception. Detailed examination will reveal changes both in the foods listed and in their analyses. These values have been carefully assembled and collated; they represent some slight improvement over the separate original sources in scope and ease of use.

The material contained herein represents, to the best of our abilities, a conservative statement of existing knowledge and opinions at the time of publication. We wish to express our gratitude to those specialists who have taken time from their clinics and laboratories to review and discuss certain sections in manuscript; acknowledgment in full is withheld only lest it embarrass them. We are indebted to authors and publishers for their permission to reprint excerpts from books and journals; references to these will be found in the text.

NUTRITIONAL DATA has been compiled to present in convenient form the basic principles and facts of nutrition. It is our hope that it will be a useful reference manual for those concerned with the theory and practice of this science. Comments and suggestions from our readers for the improvement of future editions of this work will always be welcomed.

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Mellon Institute,
Pittsburgh, Penna.

CONTENTS

CONTENTS, *Continued*

VITAMINS

Interpretation of Deficiency Signs and Symptoms

A VITAMIN is a dietary essential that the body is unable to synthesize in its own metabolism but must obtain from outside sources. The following pages summarize the known information about fat-soluble and water-soluble vitamins, their positive functions, deficiency signs and symptoms, and distribution in foods.

A word of caution about the interpretation of deficiency signs and symptoms as given for vitamins and essential elements is necessary. By strict definition:

"*The two critical tests for validity of a typical localized lesion as a specific sign of a nutritional, bodily, and particular nutrient deficiency are its experimental induction and response to therapy. Its acceptability in these respects is not demonstrated without fulfillment of the first three of the following stipulations, preferably all four:*

"*1. In an appropriate species of animal the sign is experimentally induced under conditions in which a specific dietary deficiency is a major influence.*

"*2. In animals the experimentally induced sign recedes and disappears with provision of the missing nutrient.*

"*3. In man the naturally occurring sign recedes and disappears with provision of the appropriate nutrient at a therapeutic level for a sufficient time. For the acute form the first positive response should be followed alternately by induced relapses and positive responses to therapy.*

"*4. In man the sign is experimentally induced under conditions in which a specific dietary deficiency is a major influence.*

"*Until a typical sign under these stipulations is shown to be related to more than one dietary essential it may be presumed to be specific for one.*"*

Not all of the deficiency signs given in connection with vitamins and minerals will meet these rigorous criteria. They have been demonstrated in humans or animals on diets deficient in the vitamin or mineral in question. However, qualitative and quantitative manifestations of deficiencies vary, not only among species, but also among individuals. It is possible for a deficiency, particularly a border-line one, or one of short duration, to occur without the production of some or all of these signs. Conversely, since the tissues of the body have only a limited number of ways in which they can react to adverse conditions, and since these lesions are the visible results of a complicated interplay of physical, chemical and dietary factors, the appearance of a deficiency sign is not necessarily proof of a specific deficiency. The differential diagnosis of nutritional deficiencies must be made, not only from the specific lesions appearing, but also by skillful study of the dietary history, clinical and biochemical tests, and the results of therapy with the specific factor suspected.

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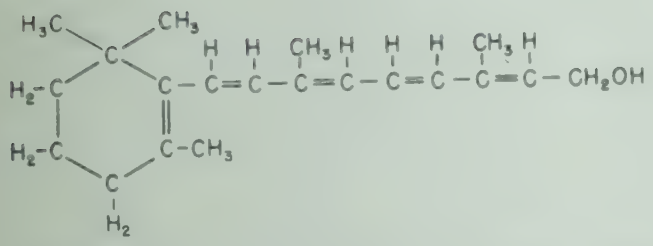
*Quoted from H. D. KRUSE, "A Concept of the Etiological Complex of Deficiency States with Especial Consideration of Conditions." *The Milbank Memorial Fund Quarterly*, Vol. 27, No. 1 (1949).

THE FAT-SOLUBLE VITAMINS

VITAMIN A: *anti-xerophthalmia factor, axeropthol*



Vitamin A_1 ($C_{20}H_{29}OH$)—A high molecular weight alcohol attached to a β-ionone ring. It is a pale, viscous, fat-soluble, unsaponifiable, heat and oxygen labile, liquid. The vitamin usually occurs in the body as a fatty acid ester.

Vitamin A is formed in the body from one of the carotenoid provitamins, *alpha-*, *beta-*, or *gamma*-carotene, or cryptoxanthin (the yellow pigments of most vegetables and fruits). *Beta*-carotene is a symmetrical molecule, consisting of two β-ionone rings connected by a conjugated chain, with a double bond in the center; upon hydrolysis it should theoretically yield two molecules of vitamin A. The biological efficiency of conversion is somewhat less. The other carotenes are asymmetrical, with one β-ionone ring, and yield even less vitamin A activity.

Vitamin A_1 is the form found in mammals and salt-water fish. An isomer A_2, with a different absorption spectrum, occurs in fresh-water fish. It has the empirical formula $C_{22}H_{31}OH$, and is believed to differ from A_1 in the terminal $-CH_2OH$ group, which is replaced by a $-CH=CH-CH_2OH$ group. The biological activity of the two isomers is about the same.

Neovitamin A is a geometrical isomer of A_1 with the same biological activity. Most liver oils contain vitamin A and neovitamin A in a 2:1 mixture.

The chemistry, isolation, and synthesis of vitamin A, and its relation to carotene, were elucidated by Karrer, Heilbron, and Holmes and Corbett, between 1930 and 1937.

Positive Functions

Essential for integrity of epithelial cells, and a stimulus for new cell growth.

Aids in maintaining resistance to infections.

Essential for regeneration of the "visual purple" (rhodopsin) when bleached by light in the visual cycle.

Increases longevity and delays senility.

Excessive carotene intake may produce carotenemia, and yellow discoloration of skin (xanthosis cutis).

Hypervitaminosis A may cause excessive bone fragility, enlargement of liver and spleen, drying and peeling of skin, loss of hair, nausea, headache, and blood dyscrasias.

Deficiency Signs and Symptoms

There is an increased need for this vitamin in infancy, pregnancy, and lactation. Various conditions may affect the absorption of A. Factors which interfere with the digestion or absorption of fat also hinder the absorption of vitamin A and carotene. Such diseases include celiac disease, sprue, pancreatic cystitis and fibrosis, and congenital atrophy of the bile ducts. Injudicious use of mineral oil in therapy may also cause poor absorption of this vitamin.

Ocular apparatus

"Bitot spots" on conjunctival membrane.

Night blindness (nyctalopia).

Xerophthalmia, keratomalacia, photophobia, conjunctivitis, and asthenopia.

Epithelial tissue

Atrophy followed by metaplastic epithelial hyperkeratinization.

Organ systems affected include the skin, digestive system, respiratory tract, genitourinary system, special senses, and endocrine system. These systems vary in their ability to withstand a deficiency of vitamin A without loss of function.

The skin changes caused by this deficiency are most apparent. They include dry, rough skin, papular eruptions, and follicular hyperkeratosis.

Bones and teeth

Impairment of epiphyseal bone formation.

Derangement in tooth formation, because of faulty development of odontoblasts.

General

Somatic changes which have been attributed to a deficiency of this vitamin include lathyrism, retarded growth, proneness to infection, intestinal disorders and general debility.

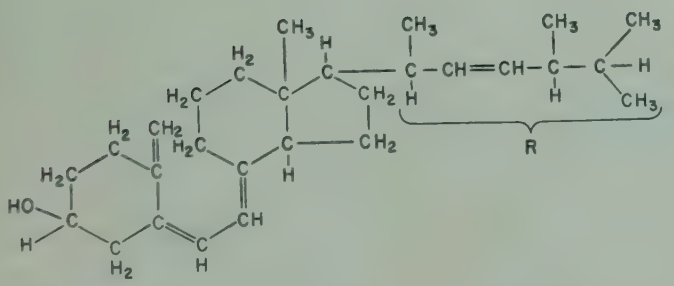
Dietary Sources*

(All values in I. U. of vitamin A per 100 g. of edible portion)

Apricots.....2790	Cantaloupe.....3420	Eggs, whole fresh 1140	Spinach.....9420
Asparagus.....1000	Chard.....2800	Kale.....7540	Squash, winter ..4950
Beet greens.....6700	Cheese (Av.)....2000	Liver, fresh....19,200	Sweet potatoes ..7700
Broccoli.....3500	Collards.....6870	Margarine (A added)	Turnip greens...9540
Butter (Av.) 3300	Dandelion	1980	Tomatoes.....1100
Carrots.....12,000	greens.....13,650	Mustard greens..6460	Tomato ketchup 1880

*Abstracted from U.S.D.A. Misc. Pub. #572; "Tables of Food Composition in Terms of Eleven Nutrients" (1945).

VITAMIN D: *the anti-rachitic factor; calciferol (D_2); activated 7-dehydrocholesterol (D_3); etc.*†



Vitamin D_2—calciferol, activated ergosterol $C_{28}H_{44}O$.

Vitamin D_3—activated 7-dehydrocholesterol $C_{27}H_{44}O$, where R is $-\underset{\displaystyle H}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{C}}}}-CH_2-CH_2-CH_2-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{CH}}}}$

White, odorless crystals, soluble in fats and organic solvents. Stable to heat, alkalies, acids, and oxidation. Formed by irradiation of sterols.

D_2 (calciferol) does not occur naturally; D_3 is formed and used by animals.

Steenbock (1924) discovered that ultraviolet radiation increased the antirachitic potency of foods. The parent substance of D was identified as ergosterol in 1927 (Windaus). Calciferol was isolated and characterized in 1930–33. The name, vitamin D, came to be applied to what was believed to be pure calciferol. This was later shown to be calciferol, with lumisterol and other substances as impurities. A preparation of purified calciferol dissolved in a suitable solvent is now given the name D_2. A preparation of irradiated 7-dehydrocholesterol is called D_3.

†The D vitamins are substances related to sterols, with anti-rachitic potency. At least 16 of these are known, with widely varying potencies, and showing marked species differences. One derivative of ergosterol, dihydrotachysterol, influences phosphorus metabolism in a manner closely resembling that of the parathyroid hormone.

VITAMIN D: Positive Effects

Enhances the absorption of calcium from the intestinal tract.

Aids in regulating blood calcium level.

May promote the conversion of inorganic phosphorus to organic forms in bone.

Excessive doses of vitamin D mobilize the phosphorus and calcium from the tissues of the body; this reverses the effect of normal doses. Symptoms of D poisoning include nausea, anorexia, diuresis, headaches, and asthenia.

Deficiency Signs and Symptoms

A deficiency of vitamin D affects chiefly the bones and teeth. This overall pattern is called *rickets* in children, *osteomalacia* in adults.

Bone changes

In shaft—Osteoid (organic matrix) deposited normally, but calcium and phosphorus salts not deposited in this.

At cartilage-shaft junction—failure of calcium salts to be deposited in the cartilaginous matrix.

Failure of cartilage cells to undergo degeneration, so that capillaries are unable to penetrate the cartilage. This results in the "rachitic metaphysis," manifested clinically as a swelling or beading of the ribs, or an increase in width of the ends of the long bones.

Various skeletal deformities result; *i.e.* bow-legs (genu varum), knock-knees (genu valgum), enlargement of the ends of the long bones, curvature of the spine (kyphosis), deformities of the pelvis or thorax.

Teeth

Teeth of rachitic children erupt late and decay early.

"Calciotraumatic line" in incisors (rats).

Hypoplasia of enamel.

Retarded calcification of cementium and predentium.

Muscle

Loss of tone of skeletal muscle and gut.

General

Retarded growth and lack of vigor.

Dietary Sources*

(I. U. or U. S. P. units per 100 g.)

Butter 8-60
Cod liver oil (U.S.P. XIII) 8500
Egg, dried whole 200
Egg yolk 150-400
Halibut liver oil (U.S.P. XIII) 60,000
Herring 1800
Liver, calf 10
Liver, pork 40
Mackerel 300-400
Milk, evaporated, fortified 28
Milk, fortified 42
Oleovitamin A&D (U.S.P. XIII) . . 8500-11,000
Concentrated oleovitamin A&D (U.S.P. XIII) 1,000,000-1,300,000
Synthetic oleovitamin D (U.S.P. XIII) (viosterol in oil) . . 1,000,000
Salmon, canned 200-800
Tuna, canned 400-1500

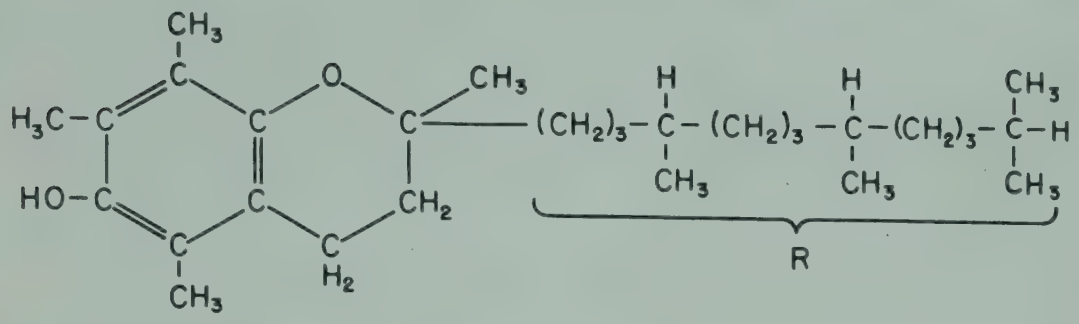
*Abstracted from the following sources:

U.S.D.A. Circular #638 (1942).

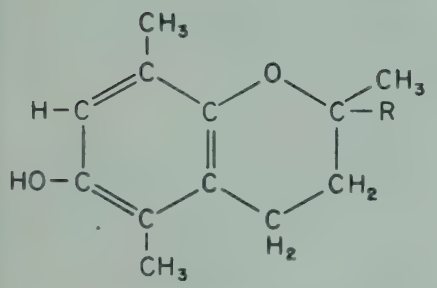
"The United States Pharmacopoeia," 13th Revision (1947).

Bicknell, F., and Prescott, F. "The Vitamins in Medicine"—Grune and Stratton, New York (1946).

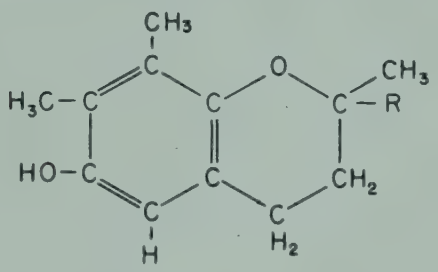
VITAMIN E: *anti-sterility factor; tocopherols (Gr. tokos—childbirth +phero—to carry)*



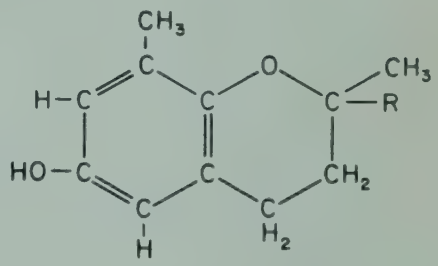
***Alpha*-tocopherol:** $C_{29}H_{50}O_2$: Mol. wt. 430.69



***Beta*-tocopherol:** $C_{28}H_{48}O_2$
Mol. wt. 416.66



***Gamma*-tocopherol:** $C_{28}H_{48}O_2$
Mol. wt. 416.66



***Delta*-tocopherol:** $C_{27}H_{46}O_2$
Mol. wt. 402.64

Viscous oils at room temperatures, soluble in fat solvents and insoluble in water. Stable to heat in the absence of oxygen, stable to strong acids and to visible light. Unstable to ultraviolet light, alkalies, and oxygen.

Biological activity destroyed by ferric salts (used in preparing E-free experimental rations) or rancid fats. Esters of tocopherols are more stable than the free phenols.

Alpha-tocopherol has the highest biological activity of the four forms, while *delta*-tocopherol is the most active antioxidant.

Evans and Bishop demonstrated the existence of an anti-sterility vitamin in 1922. It was named Vitamin E by Sure in 1924. The tocopherols were isolated in 1936; biologically active product synthesized by Karrer in 1938.

Positive Functions*

Antioxidant, which preserves easily oxidizable vitamins and unsaturated fatty acids in foods, mixtures, or the body.

Necessary for normal reproduction in many animal species. Its significance in human nutrition is not definitely established.

May act as a regulator of the metabolism of the cell nucleus, especially concerned with cell maturation and differentiation.

Tocopherols have been shown to protect against certain noxious agents, e.g., carbon tetrachloride, alloxan and methyl cholanthrene.

Tocopherols have been successfully used to treat the skin diseases known as collagenoses.

Massive doses of vitamin E have been reported to maintain normal permeability of capillaries and to protect heart muscle against degeneration. They have been used in treating cardiovascular diseases, with debatable results.

*See "Vitamin E", edited by Karl Mason. *Annals of the N. Y. Academy of Sciences* 52, C3-428 (1949).

VITAMIN E: Deficiency Signs and Symptoms

It is possible that some of these may be caused by the toxic action of peroxides of unsaturated fatty acids, produced in the absence of the anti-oxidant effects of the tocopherols.

Reproductive system

Resorptive failure of pregnancy.

Abnormal estrus cycle.

Degeneration of male germinal epithelium.

Growth

Impaired growth, both in the embryo and the young animal.

Musculature

Progressive nutritional muscular dystrophy.

Increased oxygen consumption of skeletal muscle ("in vitro").

Swelling and hyalinization of muscle fiber, which becomes necrotic.

Disappearance of motor nerve end plates.

Decreased creatine content, followed by creatinuria.

Necrosis and fibrosis of cardiac muscle fibers.

Deposition of small globules of yellow pigment in muscles and adipose tissue.

Metabolic changes

Increased oxygen consumption.

Creatinuria.

Decrease in cholinesterase activity of liver, brain, serum and muscle.

Increased phosphorus turnover.

Excretory

Parenchymatous degeneration of the kidney.

Necrosis of tubular epithelium.

In chicks

Nutritional encephalomalacia — weakness, ataxia, tremors, and retraction of the head. Caused by cerebellar lesions.

Alimentary exudative diathesis — generalized edema, with collection of fluid of the composition of blood plasma in the subcutaneous and subfascial tissues, particularly of the breast and abdomen. Fluid also collects in the pericardial and peritoneal cavities. Brain and lungs are edematous, heart and intestines are hyperemic.

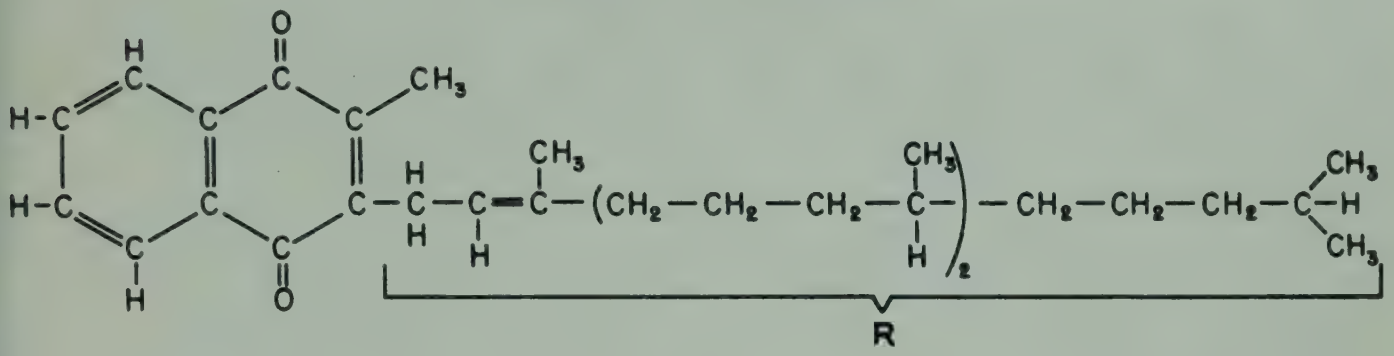
Tocopherol Content of Foods *

(Mg. per 100 g. of fresh material)

	Total	*Alpha*		Total	*Alpha*
Apples	0.74	0.72	Haddock	0.39	0.35
Bacon	0.53	0.44	Lamb chops	0.77	0.62
Bananas	0.40	0.37	Lettuce	0.50	0.29
Beans, dry navy	3.60	0.10	Margarine	54	28
Beef steak	0.63	0.47	Oatmeal	2.10	1.94
Beef liver	1.40	1.40	Onions	0.26	0.21
Butter	2.40	.....	Oranges	0.24	0.23
Carrots	0.45	0.45	Peanut oil	22	11
Celery	0.48	0.46	Peas, green	2.10	0.10
Chicken	0.25	0.21	Potatoes, sweet	4.0	4.0
Coconut oil	8.30	3.60	Potatoes, white	0.06	.....
Cornmeal, yellow	1.70	0.84	Pork chops	0.71	0.63
Corn oil	87	7	Rice, brown	2.40	1.20
Cottonseed oil	90	56	Soybean oil	140	10
Eggs, whole	2.00	1.16	Tomatoes	0.36	0.27
Grapefruit	0.26	0.25	Turnip greens	2.30	2.24

*Harris, P., M. L. Quaife and W. J. Swanson: *J. Nutrition* 40, 367 (1950).

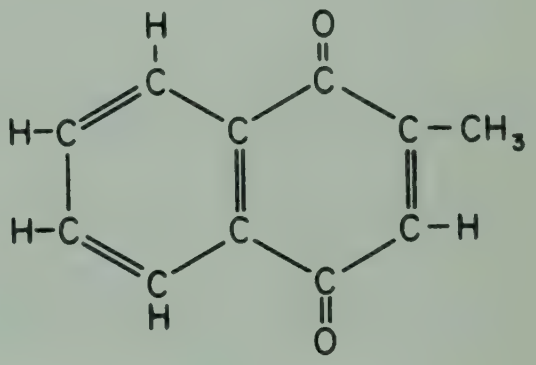
VITAMIN K: *the anti-hemorrhagic factor;* Koagulations vitamin *(Danish); phylloquinone*



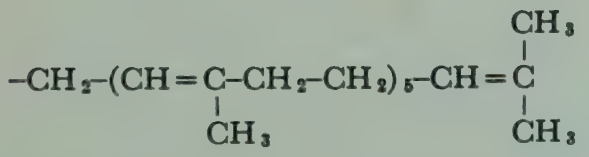
Vitamin K_1—2-methyl-3-phytyl-1,4-naphthoquinone: $C_{31}H_{46}O_2$. Mol. wt. 450.68. Yellow oil. Form isolated from green leaves.

Synthetic vitamin K; menadione.
2-methyl-1,4-naphthoquinone: $C_{11}H_8O_2$.
Mol. wt. 172.17. Yellow, crystalline powder.

Menadione is several times more active than natural vitamin K_1 and is used as a reference standard for biological assays.



Vitamin K_2—R is:



2-methyl-3-difarnesyl-1,4-naphthoquinone: $C_{41}H_{56}O_2$. Mol. wt. 580.86. Yellow crystalline solid. Isolated from putrefying fish meal.

Fat-soluble, but several water-soluble forms have been developed for therapy. Stable to heat and reducing agents. Labile to alcoholic alkali, oxidizing agents, strong acids, and light.

Fat-soluble forms require bile salts for absorption.

Postulated by Dam in 1934 as cause of a hemorrhagic disease of chicks. Isolated in 1939 by Karrer and Dam. Characterized by Doisy, Almquist, Fieser (1939).

Positive Functions

Essential for synthesis of prothrombin and normal blood clotting.

Action is apparently on liver, as it does not shorten clotting time of blood "in vitro."

Used to combat the hypoprothrombinemia of the new-born.

Ineffective in therapy of hemophilia, which is an hereditary and not a deficiency disease.

VITAMIN K: Deficiency Signs and Symptoms

May be caused by nutritional deficiency, faulty intestinal synthesis (conditioned by sulfonamides), inadequate intestinal absorption (obstructive jaundice, pancreatic insufficiency, etc.), hepatic injury, and massive hemorrhages.

Prolonged clotting time, hypoprothrombinemia.

Multiple hemorrhages, *e.g.*, in subcutaneous tissue, thymus, bladder, eye, adrenals, testis, kidney, retroperitoneal tissues, and brain.

Dietary Sources [1, 2]

(Mg. per 100 g. edible portion)

Cabbage 3.2	Cereals . . . . . <0.04-0.3	Spinach 4.6
Carrots 0.1	Liver, pork 0.4-0.8	Tomato, green 0.8
Cauliflower 3.2	Peas, green 0.3	Tomato, ripe 0.4

1. Recalculated from data in "The Vitamins in Medicine" (2nd ed.) by Bicknell and Prescott. Grune and Stratton, New York. (1946).
2. Calculated on the basis of 1,000 Dam units = .083 mg. K_1.

THE ESSENTIAL UNSATURATED FATTY ACIDS

Linoleic acid
$C_{18}H_{32}O_2$
Colorless oil.

$CH_3.(CH_2)_4.CH{:}CH.CH_2.CH{:}CH.(CH_2)_7.COOH$
Δ 9,12-octadecadienoic acid
M.P. −5.8° to −5.2° C.

Linolenic acid
$C_{18}H_{30}O_2$
Colorless oil.

$CH_3.CH_2.CH{:}CH.CH_2.CH{:}CH.CH_2.CH{:}CH.(CH_2)_7.COOH$
Δ 9,12,15-octadecatrienoic acid
M.P. 11° C.

Arachidonic acid
$C_{20}H_{32}O_2$
Colorless crystals

$CH_3.(CH_2)_4.CH{:}CH.CH_2.CH{:}CH.CH_2.CH{:}CH.CH_2.CH{:}CH.(CH_2)_3.COOH$
Δ 5,8,11,14-eicosatetraenoic acid: M.P. 77° C.

Soluble in fat solvents and alkalies, but not in water. Occur as glycerides in many natural fats and oils.

Linoleic acid is practically as widely distributed in the vegetable kingdom as ordinary oleic acid. It is a major component in various seed oils.

Linolenic acid is most familiar from its occurrence in linseed oil; it is also found in varying proportions in most vegetable drying oils, notably hemp, pine seed, walnut seed, etc.

Arachidonic acid is found primarily in fats from aquatic sources. It occurs to a lesser extent in human and animal liver and other organ fats, and sometimes in traces in the depot fats. It is also found in bird egg phosphatides, although possibly as clupanodonic acid ($C_{22}H_{34}O_2$) rather than arachidonic acid, and in the phosphatides of cotton, peanut and linseed oils.

Other "essential" acids are docosahexenoic and hexahydroxy stearic acids.

These unsaturated fatty acids are susceptible to oxidative rancidity at their double bonds. Hydrogenation reduces this tendency, but also lowers their biological value.

"*Vitamin F*" has been used by some workers as a convenient term for these acids. It has not been generally accepted; its use is considered incorrect.

Deficiency symptoms, in the rat, were first described by Burr and Burr (1929). Essential fatty acids shown to be linoleic (1930), linolenic (1932), and arachidonic (1938).

Positive Functions

Linoleic and linolenic acids appear necessary for making more highly unsaturated acids (with more than 18 carbon atoms) which play some unknown part in enabling the animal to store fat in its depots and tissues.

These higher acids include arachidonic and docasapentaenoic. It is possible that they are more efficient promoters of growth in the rat than linoleic but, although necessary for the formation of new tissue, may not be needed for the normal metabolism of the cell.

Linoleic and linolenic acids are essential for the growth and reproduction of the rat. This is a highly specific reaction, since Δ9,11-octadecadienoic; Δ10,13-nonadecadienoic; Δ11,14-eicosadienoic; Δ2-phytenoic; and Δ2,6-phytadienoic acids are all ineffective in replacing linoleic and linolenic acids for the rat.

Deficiency Signs and Symptoms

Skin and hair

Scaling, flaky desquamation (dog).

Eczema (man) claimed by Hansen.

Scaling of epidermis over dorsa of the feet and tail (rat).

Alopecia, hyperkeratosis.

Growth and reproduction (rats)

Diminished growth rate, accompanied by higher basal metabolic rate.

Disturbed ovulation and reproduction.

Resorptive failure of pregnancy, or difficult labor.

Loss of sex interest and macroscopic atrophy of the testes.

Fat and water metabolism

Fat synthesis is unaffected, but fat storage may be impaired.

Water consumption increases, urinary output remains constant.

Relation to other dietary factors

There is evidence that the essential fatty acids act jointly with pyridoxine (vitamin B_6) and pantothenic acid. The skin lesions produced by pyridoxine deficiencies or lack of the essential fatty acids are similar. It is difficult to produce typical pyridoxine deficiency if the diet contains much fat; this indicates some relationship of this vitamin to the essential fatty acids.

Dietary Sources [1]

(Percentage by weight)

Butter . . . . . 4–6% linoleic acid or its geometrical isomers; very small proportion of arachidonic acid.

Cod-liver oil . . . *See footnote 2.*

Corn germ oil . . 34–56% linoleic acid.

Cottonseed oil . . 40–55% linoleic acid.

Lard . . . . . 2–15% linoleic, 1–2% arachidonic acids.

Linseed oil . . . . 15–30% linoleic, 45–60% linolenic acids.

Olive oil . . . . . 5–15% linoleic acid.

Palm oil . . . . . 5–11% linoleic acid.

Peanut oil . . . . . 20–25% linoleic acid.

Soy bean oil . . . 52–66% linoleic, 1–6% linolenic acids.

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1. Abstracted from "The Chemical Constitution of Natural Fats" (2nd ed.) by T. P. Hilditch. John Wiley & Sons, New York. (1947).

2. Cod-liver oil is rich in unsaturated C_{18} and C_{20} fatty acids. Unfortunately, the unsaturated C_{18} acids are made up of mono-ethenoid (chiefly oleic) and tetraethenoid derivatives, while linoleic acid is either absent or present in very small amounts. Likewise, the unsaturated C_{20} acids include mono-ethenoid acids, and polyethenoid acids containing 5 or 6 ethylenic groups, but not arachidonic acid. It is believed that the "essential" fatty acid in cod-liver oil is docosahexenoic acid.

MINOR FAT-SOLUBLE VITAMINS

The following factors have been described in the literature. The exact chemical nature of some of them remains to be elucidated.

Anti-Gizzard-Erosion Factor — A fat-soluble, thermolabile factor found in kale, wheat bran and middlings, liver, kidney, and lung tissue, which prevents erosions in the lining of chick gizzards, presumably caused by a lack of bile which contains cholic acid. Chondroitin sulfuric acid appears to have the property of acting as a preventive of the gizzard lesions. The factor is not necessary for growth.

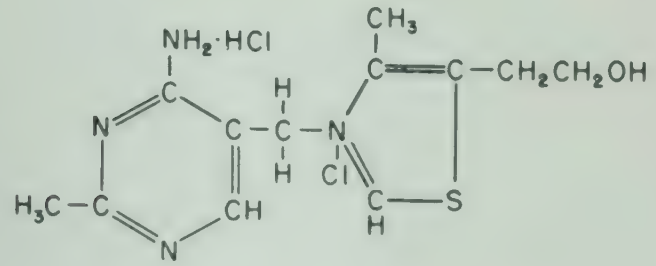
Guinea Pig Anti-Stiffness Factor—A fat-soluble, factor believed to cure a deficiency syndrome of guinea-pigs characterized by stiffness of the wrists, and ending in emaciation and death. Serum phosphatase is decreased and calcium phosphate is deposited throughout the body. Raw sugar cane juice is the best source of this factor. It also occurs in raw cream and whole milk, but not in pasteurized milk. It is also found in kale and alfalfa. It has been isolated in crystalline form, has a molecular weight of about 200, and contains one carbonyl group. Many compounds related to the sterols, such as ergostanyl acetate, have this activity.

Vaccenic acid—An isomer of oleic acid, with the double bond between the C_{11} and C_{12} carbon atoms, found in summer butter. Believed responsible for the superior growth of rats fed on summer vs. winter butter. However, pure vaccenic acid does not produce this response.

Factor T—A fat soluble factor found in sesame oil and egg yolks. Its absence causes a decrease in blood platelets in rats and man.

THE WATER-SOLUBLE VITAMINS

THIAMINE: *vitamin B_1; anti-neuritic factor; aneurin*



Thiamine hydrochloride

$C_{12}H_{17}N_4OSCl.HCl$. Mol. wt. 337.26.

2-methyl-5-(4-methyl-5-β-hydroxyethyl-thiazolium chloride) methyl-6-aminopyrimidine hydrochloride.

Colorless, monoclinic crystals, m. p. 248°–250°C. Soluble in water and alcohols. Comparatively stable toward dry heat, but destroyed by autoclaving and by sulfites.

Destruction is retarded in acid media and accelerated in alkaline media.

May be destroyed by the ingestion of live yeasts, or certain raw fish.

THIAMINE: Positive Functions

The pyrophosphate ester is called cocarboxylase. It participates in all oxidative decarboxylations which lead to the formation of CO_2. These include decarboxylation, oxidation, dismutation and condensation.

Essential for maintenance of good appetite, normal digestion, and gastro-intestinal tonus.

Necessary for growth, fertility and lactation.

Needed for normal functioning of nervous tissue, synthesis of acetylcholine.

Deficiency Signs and Symptoms

Carbohydrate metabolism is impaired; pyruvic acid accumulates in the tissues.

Cardio-vascular system

Cardiac beri-beri—Dyspnea on exertion, abnormal electrocardiagrams (reversal of T waves, and prolongation of the Q-T interval), palpitation with gallop rhythm, enlarged heart, elevated venous pressure, and diminished vital capacity. Myocardial lesions.

"*Wet*" *beri-beri*—generalized edema, probably caused by inadequate protein intake plus poor cardiac function.

Nervous system

Dry (*neuritic, paraplegic*) *beri-beri*—

Ascending, symmetrical, bilateral, peripheral neuritis.

Hyperesthesia, anesthesia, atrophy of muscles.

Degeneration of peripheral nerve fibers.

Increase in amplitude of electroencephalogram.

Brain lesions, convulsions.

Wernicke's encephalopathy—acute hemorrhagic poliencephalitis.

Gastro-intestinal system

Gastric atony, spastic colon, achlorhydria, dysphagia. Symptoms are not necessarily the same in different species.

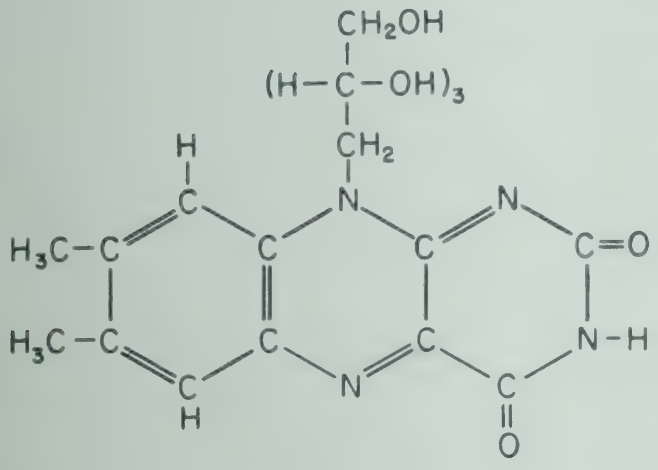
Dietary Sources*

(Micrograms per 100 g. of edible portion)

Bacon, medium fat 420	Flour, rye, whole grain . . . 470	Pecans 720
Beans, kidney or Lima, dry 600	Flour, soy 770-1100	Pork, various cuts 620-1050
Bologna 310	Flour, wheat, enriched 440	Rice, brown 290
Bread, white, enriched 240	Heart, fresh 540	Rice, converted 230
Bread, whole wheat 280	Milk, dry skim 350	Soy beans, whole 1140
Corn meal, whole grain 410-450	Milk, dry whole 300	Walnuts, English 480
Farina, enriched 370	Oatmeal 550	Wheat germ 2050
Flour, buckwheat 310	Peanuts, roasted 300	Wheat, whole grain, uncooked 450
	Peas, green 360	
	Peas, split 870	

*Abstracted from U.S.D.A. Misc. Pub. #572.

RIBOFLAVIN: *vitamin B_2 (or G); lactoflavin (from milk), ovoflavin (from eggs), hepatoflavin (from liver)*



d-Riboflavin, $C_{17}H_{20}N_4O_6$
6,7-dimethyl-9-*d*-ribityl-isoalloxazine
Mol. wt. 376.36; m.p. 282°C.

Yellowish brown needles, slightly soluble in water (12 mg./100 ml. @ 27.5°C.) where it shows a yellow-green fluorescence, very soluble in alkali. Insoluble in fat solvents. Stable to heat, in dry form and acid solution. Sensitive to light, especially in presence of alkali.

Positive Functions

Riboflavin-5-phosphate is a component of a number of flavo-protein enzymes, *e.g.* "Warburg's yellow enzyme," cytochrome-*c* reductase, riboflavin - adenine - nucleotide, as prosthetic group for a variety of proteins, which function as oxygen carriers, *e.g.*, *d*-amino acid oxidase, xanthine oxidase, succinic dehydrogenase.

These enzymes, which are capable of alternate oxidation and reduction, participate in cellular oxidation. They are believed to be especially important for respiration in poorly vascularized tissues, such as the cornea.

Deficiency Signs and Symptoms

Ocular apparatus

Corneal vascularization, cloudiness, ulceration.

Cataracts.

Photophobia, dimness of vision, impairment of visual acuity.

Congestion of the sclera.

Abnormal pigmentation of iris.

Skin

Atrophy of the epidermis and its appendages.

Scaling greasy dermatitis, especially in naso-labial folds and scrotum.

Cheilosis and angular stomatitis—lesions on lips and muco-cutaneous junction at corner of mouth.

"Shark skin" appearance of skin over nose.

Impairment of wound healing.

Nervous tissues

Myelin degeneration demonstrated in mice, dogs and swine.

Incoordination, faulty grasp reflex, loss of strength in arms and legs (monkeys).

Central neuritis, symptoms resembling degeneration of the spinal cord.

Blood

Impaired erythrocyte formation, resulting in anemia (animals). (See p. 49.)

General

Cessation of growth in the young, death in the adult.

Congenital malformation in offspring of riboflavin-deficient mothers.

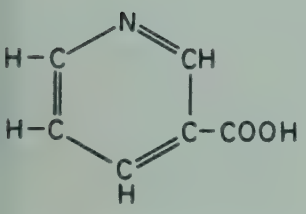
RIBOFLAVIN: Dietary Sources*

(Micrograms per 100 g. of edible portion)

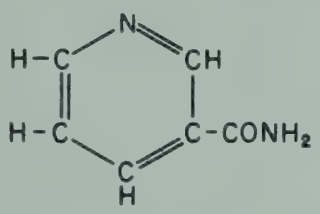
Almonds.....670	Cocoa.....390	Lamb.....250
Avocados.....150	Corn meal, yellow whole-grain.....170	Liver, fresh.....2800
Beans (dry).....240	Eggs, whole fresh.....340	Liver sausage.....1120
Beef, dried.....220	Farina, enriched.....260	Milk, dry whole.....1460
Bologna.....300	Flour, soy.....340	Milk, evap., unsweetened..360
Bread, enriched white....240	Heart, fresh.....900	Salmon, canned.....230
Bread, whole wheat.....280	Kale.....350	Turnip greens.....560
Cheese, Cheddar type....500		Wheat germ.....800

*Abstracted from U.S.D.A. Misc. Pub. #572.

NICOTINIC ACID (NIACIN): *Nicotinamide (Niacin amide); Pellagra Preventive (P.P.) factor; anti-blacktongue factor*†



Nicotinic Acid
$C_6H_5O_2N$



Nicotinamide
$C_6H_6ON_2$

Acid is a white crystalline solid, melting at 228°–229°C. Soluble in hot water and alcohol.

Stable to air, light, heat, acids, and alkalies. Not destroyed in ordinary cooking processes.

Presence in Coenzymes I and II demonstrated by Warburg, and Euler, in 1935. Effectiveness in therapy of canine blacktongue shown by Elvehjem in 1937.

Positive Functions

The amide is the functional group of Coenzyme I (diphosphopyridine nucleotide, DPN), and Coenzyme II (triphosphopyridine nucleotide, TPN)

Nicotinic acid amide — *d*-ribose — phosphoric acid ——— adenine — *d*-ribose — phosphoric acid,

(*Coenzyme I*)

Coenzyme I participates in the dehydrogenation of hexose monophosphate and triose phosphate.

Coenzyme II is concerned with the dehydrogenation of glutamate, lactate, malate, beta-hydroxy-butyrate, alcohol, and glyceraldehyde diphosphate.

The acid (not the amide) is a vasodilator. Side-actions accompanying nicotinic acid therapy may include increased cutaneous temperature, and increased peristalsis. These reactions may be minimized by the use of the amide.

†Handler, Philip, *Z. f. Vitaminforschung* **19**, 394-451 (1948) [Nutrition Foundation Reprint Series No. 392].

NICOTINIC ACID: Deficiency Signs and Symptoms

Canine blacktongue

Anorexia, buccal lesions, hemoconcentration, diarrhea, prostration and death (presumably from failure of cellular respiration).

Human pellagra

Smooth, red tongue, diarrhea, symmetrical dermatitis, neurological lesions. (Summarized in the three D's—"Diarrhea, Dermatitis, Dementia.")

It now seems clear that pellagra is not the clear-cut effect of a simple dietary deficiency, but results from a diet whose protein is of poor quality (especially lacking in tryptophane) such as corn, whose nicotinic acid content is low, and which may contain either an antinicotinic substance or a toxic material. A dietary deficiency of nicotinic acid is usually accompanied by deficiencies of other members of the B-complex.

Skin

Erythematous cutaneous eruption resembling sunburn in the early stages. Characterized by rarefaction and vasodilation in corium, disturbed keratinization in epithelium, acanthosis, bullae, and atrophic sebaceous glands.

Cutaneous manifestations may darken, desquamate and scar.

Lesions aggravated by sunlight, heat, vascular stasis, scars, burns, pressure and inflammation.

Digestive tract

Loss of appetite, nausea, vomiting and abdominal pain are early complaints.

Stomatitis

Extensive dilatation of blood vessels and atrophy of overlying epithelium in the tongue and esophagus.

Vincent's angina is a frequent complication.

Excessive salivary excretion and enlarged salivary glands.

Enteritis

Lesions in colon. Epithelium becomes atrophic. Cysts filled with mucus and polymorphonuclear leukocytes appear; ulcers may develop.

Hepatic cirrhosis

Fatty infiltration, hemochromatosis and hemosiderosis.

Diarrhea

Watery stools, which may be bloody.

Achlorhydria appears in about 50 per cent of the cases.

Nervous system

Chromotolysis of ganglion cells in brain; myelin degeneration of motor and sensory nerves.

Headaches, dizziness, insomnia, depression, and impairment of memory.

In severe cases delusions, hallucinations, and dementia may appear.

Burning hands and feet, pain in the calves, numbness, weakness, difficulty in walking, absent knee jerks, and retrobulbar neuritis.

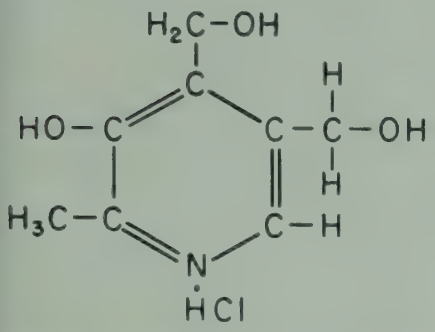
Dietary Sources*

(Mg. per 100 g. edible portion)

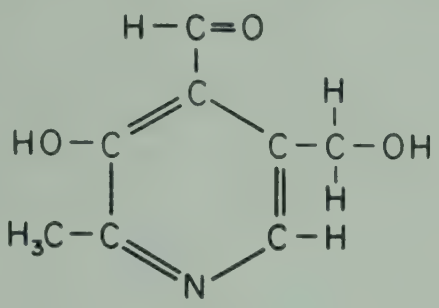
Almonds 4.6	Corn meal, yellow, whole grain 2.1	Liver, fresh 16.1	Sardines, canned . . 6.5
Avocados 1.1	Fish, misc. 4.2	Liver sausage 4.6	Tomato ketchup . . . 2.2
Beef 4.0-5.5	Flour, wheat, enriched 3.5	Peanuts, peanut butter 16.2	Tongue, fresh 5.0
Bologna 3.0	Flour, whole wheat 5.6	Peas, green 2.1	Tuna fish, canned 10.6
Bread, white, enriched 2.2	Heart, fresh 6.8	Peas, split 3.0	Turkey 7.9
Bread, whole wheat 3.5	Lamb 5.2-5.9	Pork 3.8-4.5	Veal 6.0-6.5
Chicken 8.6		Rice, brown 4.6	Wheat cereals 4.2
		Rice, converted . . . 3.8	Wheat germ 4.6

*Abstracted from U.S.D.A. Misc. Pub. #572.

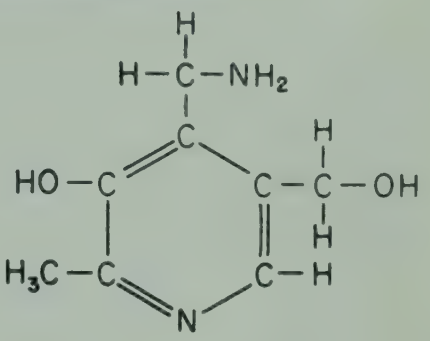
VITAMIN B_6; *pyridoxine, pyridoxal, pyridoxamine; the pyridoximers; the eluate factor; the anti-acrodynia factor; Adermin; factor 1, Y*



Pyridoxine hydrochloride
$C_8H_{11}O_3N \cdot HCl$
Mol. wt. 205.64



Pyridoxal
$C_8H_9O_3N$
Mol. wt. 167.16



Pyridoxamine
$C_8H_{12}O_2N_2$
Mol. wt. 167.16

Pyridoxine is 3-hydroxy-4,5-bis(hydroxymethyl)-2-methylpyridine.

Pyridoxine forms colorless crystals (m.p. 160°C.), soluble in water and alcohol, slightly soluble in ether and other fat solvents. It is stable to heat and alkali, but not to light, especially ultra-violet. It is more sensitive to light in neutral and alkaline solutions.

The biologically active form is pyridoxal. A microbiologically active form, "pseudopyridoxin" is a mixture of pyridoxal and pyridoxamine.

Isolated in 1938, by a number of workers, synthesized by Harris and Folkers in 1939.

Positive Functions

A product prepared by the phosphorylation of pyridoxal is the coenzyme for amino acid decarboxylase and for transaminase.

Essential for the complete metabolism of tryptophane. Pyridoxine deficient animals excrete tryptophan intermediates, and have high blood levels of creatine and uric acid.

Linked with the metabolism of the essential unsaturated fatty acids.

Can act "in vitro" as a hydrogen acceptor.

Deficiency Signs and Symptoms

Skin (rat)

Symmetrical dermatosis, affecting first the paws, then the tips of the ears, tail, and nose.

Dermal lesions are not affected by excessive sunlight or denervation, but are exacerbated by severe cold.

Cheilosis, like that of riboflavin deficiency.

Equivocal results have been reported from the use of pyridoxine in the therapy of human dermatitis; its connection with this condition can not be considered proved.

Blood and blood-forming tissues

Microcytic, hypochromic anemia, with anisocytosis and irregular reticulocytosis.

Extensive deposition of iron pigment (hemosiderin?) in liver, spleen, and bone marrow which is hyperplastic. (See p. 49.)

Rise in serum iron content parallels the severity of the anemia.

Nervous system

Epileptiform fits demonstrated in rats, dogs, and pigs; hyperirritability, ataxia.

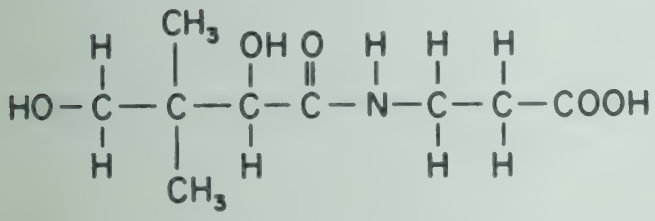
PYRIDOXINE: Dietary Sources*

(Micrograms per 100 g. of edible portion)

Apples 26	Cabbage 290	Milk, whole 6	Potatoes, Irish 160
Bananas 300	Cantaloupe 36	Molasses 270	Potatoes, sweet . . . 320
Beans, dried Lima 550	Cauliflower 20	Oranges 80	Spinach 83
Beef, liver 800	Cheese 66	Peas, fresh 50-190	Turnips 100
Beef heart 120	Chicken 25-130	Peas, dried 300	Veal chop 56-130
Beef round 77	Eggs 22	Peanuts, roasted . . 300	Wheat germ 600
Bread, whole wheat 38	Halibut 110	Pork, loin 86-270	Wheat, whole 210
	Lettuce 71		

*Cheldelin, V. R. and Williams, R. J., "The Vitamin Content of Tissues II," Univ. of Texas Pub. #4237, p. 105 (1942).

PANTOTHENIC ACID: *pantothen; filtrate factor; chick anti-dermatitis factor; chick anti-pellagra factor; Factor II; anti-chromotrichia factor (anti-gray-hair factor)*



Pantothenic acid, $C_9H_{17}O_5N$. Mol. wt. 219.23 (+)–2,4-dihydroxy-3,3-dimethylbutyryl-beta-alanine.

Yellow viscous oil. Usually sold as the calcium salt. The free acid is amphoteric, readily soluble in water and acetic acid, slightly soluble in ether, almost insoluble in other fat solvents.

Stable to oxidizing and reducing agents, and autoclaving. Labile to dry heat, hot alkali, or hot acid, and cold acid alcohol.

Isolated as factor in 1933, in pure form in 1939 and synthesized in 1940 (R. J. Williams, and others).

Positive Functions

Essential for all living organisms, including man.

Is a component of coenzyme A, involved in the acetylation of aromatic amines and choline. May also be concerned with fat and carbohydrate metabolism.

Related to utilization of other vitamins, especially riboflavin.

Necessary for normal hatching of eggs.

May be a growth factor to promote vitamin synthesis by the intestinal flora.

Deficiency Signs and Symptoms

Skin and hair (esp. in rat)

Circumocular loss of hair (spectacle alopecia).

Graying of the hair observed in rats, mice and silver foxes (not in humans), "nutritional achromotrichia."

Generalized scaling and erythematous dermatitis; occasional foci of eczematous dermatitis.

Harderian gland

"Blood-caked" whiskers in rats (chromodacryorrhea).

This pigment is said to be coproporphyrin, a red pigment produced by the Harderian glands, and excreted through the nasolacrimal duct in deficient animals.

Deficiency Signs and Symptoms, *Continued*

Intestinal tract

Diarrhea with bloody stools.

Diffuse hyperemia of intestine, followed by necrosis of the epithelium. Abscesses develop, which rupture and leave large ulcers.

Nervous tissues

Disturbed gait; "goose-stepping syndrome"—progressive impairment of gait until animal can't walk and lies prostrate (swine).

"Burning" hands and feet (humans).

Chromotolysis of the dorsal root ganglion cells.

Myelin degeneration of peripheral nerves.

Miscellaneous

"Hemorrhagic necrosis" of the adrenal glands of rats: hemosiderin deposition, fibrosis, "congestion," hemorrhage, cellular atrophy, necrosis, and scarring.

Fatty livers and spasticity of hind quarters (dogs).

Resorptive failure of pregnancy (rats).

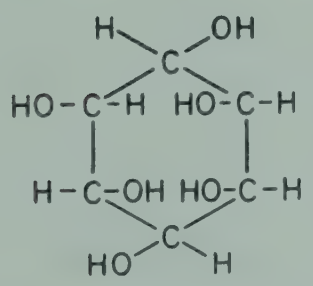
Dietary Sources[1,2]

(Micrograms per 100 g. edible portion)

Beans, dried Lima 830	Cauliflower 920	Oranges 340	Potatoes, Irish 400-650
Beef, brain 1800	Cheese 350-960	Oysters 490	Potatoes, sweet . . . 940
Beef, heart 2000	Chicken 530-900	Peas, fresh . . 600-1040	Salmon 660-1100
Beef, liver 5200	Eggs 2700	Peas, dried 2800	Soy beans 1800
Beef, muscle 1100	Lamb 600	Peanuts, roasted . . 2500	Veal chop . . . 110-260
Bread, whole wheat 570	Milk, whole 290	Pork, bacon . . . 280-980	Wheat, whole . . . 1300
Bread, white 400	Mushrooms 1700	Pork, ham 340-660	Wheat, germ 2000
Broccoli 1400	Oats 1300	Pork, muscle 470-1500	Wheat, bran 2400

1. Cheldelin, V. H., and Williams, R. J., Univ. Texas Pub. #4237, (1942).
2. Jukes, T. H.: *J. Nutrition* **21**, 193 (1941).

INOSITOL: *mouse anti-alopecia factor; Bios I; muscle sugar**



Meso-, or i-inositol

Hexahydroxy cyclohexane

$C_6H_{12}O_6$: Mol. wt. 180.16

White crystals, m.p. 225-226°C.

There are seven optically inactive and one pair of optically active forms of inositol. Only the optically inactive *meso-* form illustrated is nutritionally active.

Meso-inositol occurs in nature in the free form, as methyl esters, and in a variety of phosphoric esters and complexes. Phytin, the mixed hydrogen-calcium-magnesium salt of inositolhexaphosphoric acid, occurs in cereal grains, soils, and avian erythrocytes. Phosphoinositides occur in plant and animal phosphatides, while a water-soluble, non-dialysable complex is found in animal tissues.

Inositol was first isolated in 1850 by Scherer, and was characterized by Maquenne in 1887. Its stereochemical configuration was given by Dangschat and Fisher in 1942. Shown to be a dietary essential for mice in 1940 by Woolley.

*See "Les Inositols, chemie et biochemie" par Fleury, Paul, et Balatre, Paul. Masson et Cie, Paris. 1947.

INOSITOL: Positive Functions

Significance in human nutrition not yet established. May be a "secondary accessory" factor, stimulating microorganisms to synthesize other vitamins which are needed.

Believed to be concerned in fat and cholesterol metabolism.

Inositol is required for the growth and reproduction of some yeasts, fungi, and mutant strains of *Neurospora crassa*. It has not been shown to be required for the growth of any bacterial species.

Serves as a limited source of reserve carbohydrate for muscle activity.

A growth factor for rodents; necessary for normal reproduction in hamsters, growth factor for turkeys.

Is reported to serve as a decholesterizing agent for mobilizing cholesterol and its esters from the tissues of old hens.

Deficiency Signs and Symptoms

Alopecia in mice. Hair is never lost from head or tail, nor legs below the knees, but loss on other parts of the body is nearly complete.

Circumocular alopecia (spectacle eye) in rats, although there probably must be concurrent deficiencies in pantothenic acid or biotin to produce this lesion.

Impaired growth rate of mice, rats, cotton rats and guinea pigs.

Nutritional encephalomalacia and exudative diathesis of E-deficient chicks (see p. 6) can be prevented by feeding inositol.

Increased gastric emptying time, with gastrointestinal hypertonicity and hypomotility.

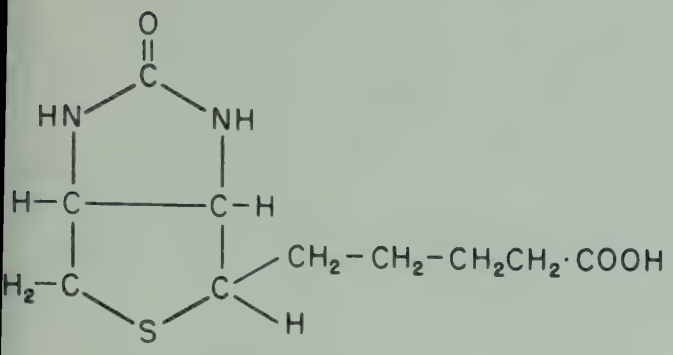
Dietary Sources*

(Mg. per 100 g. edible portion)

Apples 24	Cantaloupe 120	Lettuce 55	Potatoes, Irish 29
Bacon 43-64	Carrots 48	Milk, whole 18	Potatoes, sweet 66
Bananas 34	Cauliflower 95	Mutton 50	Raisins 120
Beans, dried Lima 170	Cheese 25	Mushrooms 17	Salmon 17
Beef brain 200	Chicken 47	Onions, dry 88	Spinach 27
Beef heart 260	Chocolate 85	Oranges 210	Strawberries 60
Beef liver 51	Cornmeal, white . . . 45	Oysters 44	Tomatoes 46
Beef round 11	Eggs, whole fresh . . 33	Peaches, frozen 96	Turnips 46
Beets 21	Grapefruit 150	Peanuts, roasted . . 180	Veal chops 32-35
Bread, white 51	Halibut 17	Peas, dried 330	Watermelon 64
Bread, whole wheat 67	Ham 31-58	Peas, green 162	Wheat germ 690
Cabbage 95	Lamb, leg 58	Pork loin 36-45	Wheat, whole 170

*Cheldelin, V. H. and Williams, R. J., "The B Vitamin Content of Foods," Univ. of Texas Pub. #4237 (1942).

BIOTIN: *anti-egg-white injury factor; vitamin H; Coenzyme R; factors S; W; X; Bios IIb*



Biotin
Hexahydro-2-oxo-1-thieno-(3,4)-imidazole-4-valeric acid
$C_{10}H_{16}O_3N_2S$ Mol. wt. 244.3

Long thin needles, melting at 230-232°C., with decomposition. Sparingly soluble in water, insoluble in alcohol and fat solvents. Biotin is relatively stable towards heat, dilute acids and alkalies. The sulfur atom is easily oxidized.

Combines with avidin, a glycoprotein in raw egg white, to form a stable complex, which cannot be broken down by proteolytic digestion, but only by heating. Biotin so combined is nutritionally unavailable. Avidin was the first known example of an antivitamin.

Postulated by Boas in 1927; isolated in 1936 (Kogl and Tonnis); structure established 1941-1942 by Du Vigneaud, *et al.;* and synthesized in 1943 by Harris and Folkers.

Positive Functions

Believed to be involved in fat metabolism; feeding excess biotin to rats results in an abnormal increase in fat and cholesterol synthesis by liver.

May be related to pyruvate and lactate metabolism; liver slices from biotin-deficient animals show an increase in lactate utilization when biotin is added to them "in vitro."

Regulates the cellular fixation of CO_2.

Is probably coenzyme for oxalacetate decarboxylase. This finding relates it to fat and carbohydrate metabolism.

Improves "lactation performance" in rats.

May be involved in the fundamental mechanisms of growth, since biotin content of certain embryo and tumor tissues is high.

Deficiency Signs and Symptoms

May be produced by dietary deficiency, impaired intestinal synthesis by micro-organisms, or combination with avidin of raw egg white.

Skin

Characteristic seborrheic skin disease. Generalized erythema, followed by scaling and alopecia. Animals are covered with brown, greasy scales.

Circumocular alopecia (spectacle eye) in rodents.

Fine, scaly dermatitis noted in human volunteers on 200 g. dried egg white daily.

Nervous tissues

Abnormal humped posture and spastic gait noted in deficient rats. This is not accompanied by demonstrable lesions in the nervous system.

Muscle tissues show atrophy, necrosis of fibers, and an increase in sarcolemma resembling that seen in tocopherol deficiency.

Biotin deficiency in man

Skin lesions, grayish skin color, atrophy of the lingual papillae, anorexia, extreme lassitude, sleeplessness, and muscle pain. Precordial distress and electrocardiographic changes.

Spontaneous biotin deficiency in man seems unlikely, as balance studies indicate that biotin is synthesized by the intestinal flora in sufficient quantities to render an exogenous source unnecessary. It is unlikely that a normal diet would contain sufficient avidin from egg whites to produce a biotin deficiency.

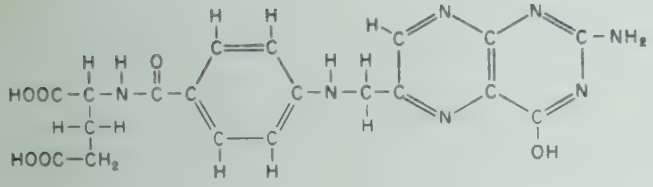
BIOTIN: Dietary Sources [1, 2]

(Micrograms per 100 g. of edible portion)

Bananas 4	Chocolate 32	Molasses 9	Pork, bacon 7
Beans, dried Lima . . 10	Corn 6	Mushrooms 16	Pork, muscle 2-5
Beef 4	Eggs, whole fresh . . 25	Onions, dry 4	Salmon 5
Carrots 2	Grapefruit 3	Oysters 9	Spinach 2
Cauliflower 17	Halibut 8	Peas, fresh 2	Strawberries 4
Cheese 2	Liver, beef 100	Peas, dried 18	Tomatoes 2
Chicken 5-10	Milk 5	Peanuts, roasted . . . 39	Wheat, whole 5

1. Cheldelin H. and Williams R. J., Univ. Texas Publication #4237, p. 105 (1942).
2. Elvehjem, C. A., *J.A.M.A.* **138**, 960 (1948).

FOLIC ACID: *Folacin; Pteroylglutamic Acid, generic term for a group of factors formerly known as vitamin M, vitamin B_c, factor U, L. casei factor, Norite eluate factor* *



Pteroylglutamic acid: N-[4-{[(2-amino-4-hydroxy-6-pteridyl) methyl] amino} benzoyl] glutamic acid; $C_{19}H_{19}N_7O_6$, Mol. wt. 441.21—natural *L. casei* factor.

Pteroyltriglutamic acid—synthetic *L. casei* factor.

Pteroylheptaglutamic acid—vitamin B_c conjugate from yeast.

Bright yellow needles or platelets. Free acid slightly soluble in water, while the salt is much more soluble.

Readily destroyed by heat in acid media. Solutions deteriorate when exposed to sunlight. Appreciable loss in foods stored at room temperature, and in cooking.

Positive Functions

Used for therapy of macrocytic anemias, and sprue.

Inhibits certain carcinomas in mice.

Growth factor for micro-organisms.

Improves lactation in rats and mice.

Improves hatchability of chick eggs.

Required for growth and blood formation in chicks, monkeys, fox, and minks.

Converts megaloblastic bone marrow to normaloblastic type.

Essential for normal metabolism of growing cells and tissues.

Deficiency Signs and Symptoms

Megaloblastic erythropoesis.

Nutritional cytopenia.

Paralysis (turkeys).

Hydrocephalus (rats).

Infarction of the spleen (rats).

Endocrine disturbances (chicks).

Weight loss, lethargy interspersed with convulsions (guinea pigs).

*For a recent review see Jukes, T. H. and Stokstad, E. L. R.: *Physiol. Rev.* **28**, 51, (1948).

FOLIC ACID: Dietary Sources [1, 2]

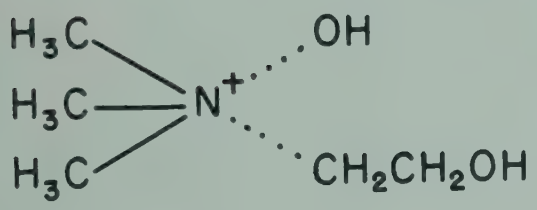
(Micrograms per 100 g. of edible portion)

Asparagus . . 118-124
Bananas 95
Beans, dried Lima 330
Beans, green 71*
Beans, wax 23-27*
Beef, liver 380
Beef round 100
Beets 42*
Beets, green 25*
Bread, whole wheat 69
Broccoli 90-110
Cantaloupe 130
Carrots 97
Cauliflower 44*
Cheese 30
Chicken 120-250
Eggs 86
Endive 62-75*
Ham 58-120
Kale 100-92*
Lettuce, leaf . . . 69-84*
Mushrooms 98
Oranges 83
Oysters 240
Parsley 170*
Peanuts, roasted . 280
Peas, green 22-23
Pork loin 65-140
Potatoes, Irish . . . 140
Radishes 11-13
Salmon 870
Spinach 225-280*
Swiss chard . . . 62-70*
Tomatoes 12-14*
Veal chop 92-170
Watermelon 150
Wheat, whole . . . 190
Wheat germ 280-330*

1. Cheldelin, V. H. and Williams, R. J., in "The Vitamin Content of Tissue II," Univ. of Texas Pub. #4237 (1942).
2. Fager, E. E. C., Olson, O. E., Burris, R. H. and Elvehjem, C. A.: *Food Research* **14**, 1 (1949).

*These values are from reference No. 2. The first of the two figures given is from the use of *L. casei*, the second from *S. faecalis*.

CHOLINE: *bilineurine*



Choline: Hydroxyethyl-trimethyl ammonium hydroxide: $C_5H_{15}O_2N$
Mol. wt. 121.13

A quaternary ammonium compound. Colorless, viscous liquid, soluble in water and alcohol, unstable to alkali.

Occurs in the body in combined form in phospholipids or acetylcholine. May be excreted in the urine as trimethylamine [$(CH_3)_3N$].

Nutritional importance first shown by Best and Hershey in 1932. Effect on kidney described by Griffith and Wade (1939); effect on liver shown by Gyorgyi and Goldblatt (1940). Interrelationship of choline, methionine and homocystine, and the role of choline in transmethylation demonstrated by Du Vigneaud (1941–42).

Positive Functions

Used in the synthesis of certain substances necessary for fat transport. Enhances the transport of fatty acids from the liver to fat depots. Capable of preventing and curing fatty livers and certain types of liver cirrhoses.

Acts as a donator of labile methyl groups. In methionine-deficient rats, choline furnishes methyl groups to homocystine to synthesize methionine, and thence to guanidoacetic acid to form creatinine. (See p. 55.)

Acetylcholine is assumed to be the transmitter of the excitatory state across ganglionic synapses and neuromuscular junctions in voluntary muscles.

Necessary for all animals, especially the young. Can be partially replaced by methionine or betaine.

Essential for the normal nutrition of the chick and for egg production; for the prevention of perosis (slipped tendon) in some fowl; and essential for growth, reproduction, lactation and general nutrition in the rat.

CHOLINE: Deficiency Signs and Symptoms

Liver

Fatty infiltration. Hepatic cells become greatly distended with fat. Necrosis and scarring.

Disturbed hepatic function (longer bromsulfalein time and prothrombin time, elevated serum phosphatase). These changes are especially marked on a high fat (20%) and low protein (4–5%) diet.

Kidney

Produces dilatation and hemorrhage of the peripheral cortical vessels and necrosis of the renal tubular epithelium.

Grossly, affected kidneys are enlarged, with a mottled, reddish color.

Kidney has increased fat content and decreased alkaline phosphatase activity.

Lesions are influenced by cystine, fat, and protein content of diet, as well as the type of dietary carbohydrate.

Miscellaneous lesions

Hemorrhages in eyes; glomerular layer of the adrenal glands: intracranial hemorrhages in young born to choline-deficient females.

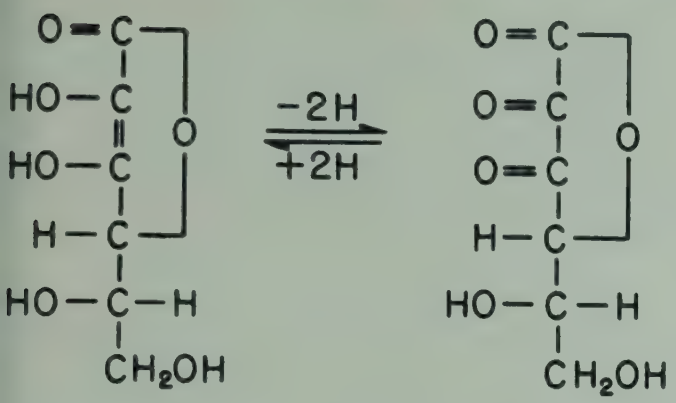
Dietary Sources [1, 2]

(Mg. per 100 g. of edible portion)

Asparagus 130	Cheese, cheddar . . 50	Milk, dry skim . . 160	Pork 75-100
Beans, snap 340	Corn germ . . 67*-160	Milk, dry	Potatoes,
Beans, soy . . . 300-340	Corn, whole 37	whole 80*-110	Irish 20*-105
Beef 90	Egg yolk . 1130*-1700	Milk, whole, fresh 15	Potatoes, sweet . . . 35
Beet 8*	Kidney, lamb . . . 360	Oats, rolled 150	Spinach 240
Bologna 70	Lamb 110	Peanuts 160-170	Trout 87
Butter 8*	Liver, beef . . 480-700	Peanut butter . . . 145	Turnips 94
Cabbage 7*-250	Liver, pork . . 470-620	Peas 260	Wheat germ 400
Carrots 95	Liver sausage . . . 270	Pecans 50	Wheat, whole 90

1. Engel, R. W.: *J. Nutrition* **25,** 441-6 (1943). Analytical method is chemical, precipitating the choline as a reinecke salt.
2. Horowitz, N. H. and Beadle, G. W.: *J. Biol. Chem.* **150,** 325-333 (1943). Determine choline microbiologically by the growth of a cholineless mutant of *Neurospora crassa*. Values marked * are from this paper.

VITAMIN C: *ascorbic acid; anti-scorbutic factor; cevitamic acid* (obs.)



Ascorbic acid $C_6H_8O_6$

Dehydroascorbic acid $C_6H_6O_6$

Ascorbic acid forms colorless crystals (m.p. 190°–192°C.), freely soluble in water, and slightly soluble in acetone and the lower alcohols. It is insoluble in benzene, ether, chloroform, fats, and other fat solvents.

Dehydroascorbic acid is the first oxidation product of ascorbic acid. The anti-scorbutic potency of the two forms is about the same.

Least stable of the vitamins, sensitive to alkalies and to oxidation, especially in the presence of iron or copper ions. Fairly stable in acid solution.

First isolated in 1928 by Szent-Gyorgyi, and called hexuronic acid. Isolated and identified as the anti-scorbutic principle by King and Waugh in 1932. Characterized in 1933 by Haworth, Hirst, Karrer, and others. Synthesized in the same year by Reichstein, Haworth, and Hirst. Name, *ascorbic acid*, suggested in 1933 by Szent-Gyorgyi and Haworth.

Positive Functions

Necessary for the formation of intercellular substance (*e.g.*, reticulum and collagen) in the animal organism. Other intercellular substances regulated include dentine, cartilage and the matrices of bone. Therefore, it plays an important role in tooth formation, bone formation and repair, production of bone salts, formation of callus in the union of fractured bones, and wound healing.

Necessary, either alone or in combination with vitamin P, for maintenance of capillary integrity and prevention of permeability.

May be involved in the maturation of the red blood cell, the absorption and utilization of dietary iron, and the maintenance of normal blood hemoglobin levels.

Related to the metabolism of the aromatic amino acids, phenylalanine and tyrosine. Apparently C-deficient tissues are unable to oxidize the side chain of tyrosine. Other metabolic defects noted in C-deficient tissues include decreased succinic dehydrogenase activity of heart and skeletal muscle, increased blood fibrinogen, and decreased serum phosphatase activity in infants and guinea pigs, but not in adult humans.

Vitamin C has frequently been suggested as a component of a reversible oxidation-reduction system in the body, acting as a hydrogen transporter. This is an attractive theory, but so far no definite proof of it has been offered.

A relationship may exist between vitamin C and the production of the adrenal-cortical hormones. This is especially interesting in view of the high concentration of ascorbic acid in the adrenals. Other organs rich in ascorbic acid include the corpus luteum and the anterior and intermediate lobes of the pituitary.

There may also be a relationship between vitamin C and vitamin A. Rats on high protein diets deficient in vitamin A develop hemorrhagic symptoms that are alleviated by ascorbic acid. Conversely, vitamin C can moderate the toxic signs of rats given huge doses of vitamin A.

VITAMIN C: Deficiency Signs and Symptoms

Scurvy is the classical manifestation of severe vitamin C deficiency. It is characterized by weakness, spongy gums, loose teeth, resorbed dentine, swollen, tender joints, and hemorrhages in various tissues. In the United States infantile scurvy is the form most frequently seen.

Environmental factors are "ignorance, apathy, and poverty." Conditioning factors other than a scorbutic diet include climate, composition of the food in relation to other vitamins and minerals, constitution of the subject, condition of internal secretions, presence of infection, and condition of the alimentary tract.

Impaired collagen formation

Delayed healing of wounds. Although there is extensive fibroblastic proliferation, the cells are immature and fail to lay down collagen. Hematoma is absorbed much more slowly, and capillary loops fail to invade the injured area. The tensile strength of healing wounds is much lower in scorbutic animals.

Bone changes

The scorbutic condition is characterized by the failure of intracellular substances to be elaborated. There is a failure of the osteoblasts to form osteoid, the organic matrix of bone.

A wide zone of calcified but unossified matrix develops below the cartilaginous plate. This "scorbutic lattice" is especially liable to fracture. Fractures usually appear at the periphery of the bone where the cortex joins the cartilage.

Teeth and supporting structures

Odontoblasts become atrophic and disorganized. Dentine is laid down irregularly or not at all, while the predentine becomes hypercalcified.

Changes in the enamel organ come later. Ameloblasts atrophy and hemorrhages are encountered. These may be caused by traumatic changes of the enamel organ resulting from poor support.

There is no definite evidence of any relationship between ascorbic acid deficiency and dental caries. Few, if any, cases of gingivitis and oral bleeding result from ascorbic acid deficiency when dental hygiene is maintained.

Capillary fragility

Although multiple hemorrhages are part of the classical pattern of scurvy, there is little agreement between the results of capillary fragility tests and blood vitamin C studies. It is probable that a deficiency of vitamin P is a participating factor in this syndrome.

Dietary Sources [1, 2]

(Mg. per 100 g. of edible portion)

Asparagus 33	Collards 100	Liver, fresh 31	Rutabagas 36
Beans, Lima, green 32	Dandelion greens . . . 36	Mustard greens . . . 102	Spinach 59
Beet greens 34	Grapefruit 40	Okra 30	Strawberries 60
Broccoli 118	Grapefruit juice 35	Oranges 49	Sweet potatoes 22
Brussels sprouts 94	Grapefruit segments 30	Orange juice 42	Tangerines 31
Cabbage 52	Kale 115	Peas, green 26	Tomatoes 23
Cantaloupe 33	Lemons 45	Peppers, green . . . 120	Tomato juice 16
Cauliflower 69	Limes 27	Pineapple, fresh . . . 24	Turnip greens 136
Chard 38		Radishes 24	Turnips 28

1. Abstracted from U.S.D.A. Misc. Pub. #572.
2. The table is based upon the ascorbic acid content in the fresh raw state, or when cooked or canned carefully. Open kettle cooking, wilting, etc., may readily destroy most of the ascorbic acid value of foods. See p. 72.

MINOR WATER-SOLUBLE VITAMINS

The following factors have been described in e literature. The chemical structure, and/or tus as vitamins of some of them remain to be icidated. Many other factors fitted at one ne into this category; some of these will be ind as synonyms for other vitamins, some ve lapsed into obscurity.

Vitamin B-complex

"Exclusive of ascorbic acid, it is a composite of the water-soluble vitamins found in yeast and er. Included among the vitamins is a heteroneous conglomeration of compounds whose uctures differ greatly and whose functions, as as known, differ even more. Their common tures are that they are not built up by the dy, at least in the amount needed, and that ey carry on their several functions when esent in small concentration or only in traces." uoted from an article by T. D. Spies in n. *Rev. Biochem.* **17**, 449 (1948)].

Adenylic Acid (*adenosine-5'-monophosphoric acid, vitamin B_8*)

A complex of adenine, ribose and phosphoric d widely distributed in cereals, glandular sues, muscle, and yeast. Constituent of Cozymes I and II. Has powerful pharmacologic ion, but vitamin status is indefinite.

Vitamin B_{12}

A crystalline red, heat-stable compound which s been isolated from commercial liver extracts d microbiological sources. Molecular weight about 1500; the formula is probably $_{1\text{-}64}H_{86\text{-}92}N_{14}O_{13}PCo$. It is a cobalt coordination complex, with the phosphorus present as osphate. A crystalline hydrogenation product, own variously as B_{12a} or B_{12b}, has approxitely the same biological potency.

Vitamin B_{12} has shown hematopoietic activity pernicious anemia, nutritional macrocytic emia and sprue. It is a growth factor for ldren and microorganisms. It has been shown possess "animal protein factor" activity for ck growth.

Milk, cheese, meats and egg yolks are good rces of this vitamin.

Para-amino Benzoic Acid (PAB)

Shown by Ansbacher [*Science* **93**, 164 (1941)] to be an anti-gray hair factor for the rat and a growth promoting factor for the chick. Shown to be a growth factor for some bacteria by Rubbo (1940). Found in yeast, liver, wheat germ, etc. The characterization of pteroyl glutamic "folic" acid [Ansbacher: *Science* **103**, 667 (1946)] showed it to contain a PAB moiety. It is believed that PAB may be important as a precursor of folic acid. It has been used in the chemotherapy of typhus and Rocky Mountain spotted fever [*J.A.M.A.* **132**, 911 (1946)].

Strepogenin (*Chick growth factor S*)

Nutritional factor found in some proteins. Necessary for maximal growth of animals. Probably a small peptide of acidic character. Synthetic seryl glycyl glutamic acid has some strepogenin activity, but is probably not identical with the natural substance. [Discovered by Woolley, D. W.: *J. Exptl. Med.* **73**, 487 (1941); for further information see the review by Woolley in *Ann. Rev. Biochem.* **16**, 376 (1947)].

"Vitamin P" and Rutin

The existence of vitamin P was postulated in 1936 by Szent-Gyorgi [*Deutsch. med. Wschr.* **62**, 1325] who noted the presence of a substance other than ascorbic acid in Hungarian paprika and lemon peels which protected against capillary fragility and permeability. The active fraction of vitamin P extracted from lemon peels is a mixture of hesperidin and eriodictyol glucoside known as citrin. Other sources rich in P activity are oranges, lemons, grapes, plums, and black currants.

Rutin, the rhamno-glucoside of quercetin, which has been isolated from tobacco leaves and buckwheat, resembles vitamin P in structure and activity. It was first tested clinically in 1944 by J. Q. Griffith, Jr. [*Proc. Soc. Expt. Biol. Med.* **28**, 228 (1944)], and has since been used extensively for the control of capillary fragility. Rutin may enhance the biologic value of ascorbic acid or inhibit hyaluronidase activity.

VITAMIN UNITS

THE PRACTICE of expressing the strength of a vitamin preparation in "units" is a relic of the days before isolation of the pure chemical substance. Units represent the first approximation attempt at dealing quantitatively with the new factor in question, and were a convenient device to express the activity of a preparation containing an unknown amount of an uncharacterized material. The availability of crystalline vitamins made it possible and desirable to work in terms of milligrams or micrograms of the pure substance.

The accuracy of any assay is enhanced when a standard product is available for comparison. Standard vitamin preparations were first made available by the Permanent Commission on Biological Standardization of the Health Organization of the League of Nations and distributed through National Control Centers to qualified investigators. These standards are widely used for research and to prepare working standards for use by manufacturers and enforcement agencies. International standards have been established for vitamins A, B_1, C, D and E. An "International Unit" is, by definition, based on the activity of an International Standard preparation. The United States Pharmacopoeial Convention has been designated as the Control Center for the United States. Its Committee on Reference Standards has extended the work of the original Commission until USP standards for ascorbic acid, calcium pantothenate, choline chloride, nicotinamide, nicotinic acid, pyridoxine hydrochloride, riboflavin, thiamine hydrochloride, vitamin A and vitamin D (forms for both rat and chick assay) are now available. (Address USP Reference Standards, 4738 Kingsessing Ave., Philadelphia 43, Pa.) When an International Standard exists, the U.S.P. standard is compared and brought as closely as possible into agreement. Therefore, a "USP unit" is equal to an "International Unit."*

The existence of adequate standards has proved a boon, both to research workers and Federal and state control officials.

Vitamin A

1 I.U. = 1 USP unit = that amount of vitamin A activity contained in 0.6 micrograms of International standard *beta*-carotene. Standard USP reference preparation is now an oil solution of crystalline vitamin A acetate, containing 10,000 USP units per gram. (First USP XIII sheet supplement, official Jan. 1, 1948.)

Vitamin B_1: thiamine hydrochloride

1 I.U. = 1 USP unit = the B_1 activity of 3.0 micrograms of crystalline thiamine hydrochloride. Original standard was a particular sample of an adsorption product on fullers' earth of an extract of rice polishings; the unit was the activity of 0.01 g. of this preparation.

Vitamin C: ascorbic acid

1 I.U. = 1 USP unit = the vitamin C activity of 0.05 mg. of *l*-ascorbic acid. The original unit, approximately equal in activity, was 0.1 ml. of the freshly expressed juice of the lemon, *Citrus limonum*.

Vitamin D (for humans and four-footed animals)

1 I.U. = 1 USP unit = vitamin D activity of 0.025 micrograms of crystalline vitamin D_3 (calciferol).

Vitamin E: alpha-tocopherol

1 I.U. = 1 USP unit = the vitamin E activity of 0.1 g. of the International Standard solution, containing 1.0 mg. of synthetic racemic *alpha*-tocopherol acetate.

Other vitamins

The activity of other vitamins is expressed as the weight in milligrams or micrograms of the various chemically pure materials.

*Although this 1:1 relationship is generally true, there seems to be a discrepancy in the value of the two units for vitamin A. Disagreement exists on the proper factor to be used in converting spectroscopic readings into units. The statement has been made [COWARD, *Biological Standardization of the Vitamins* (2nd ed.) p. 56. Bailliere, Tindall & Cox, London (1947)] that the U.S.P. unit has about 2619/3000 of the value of the International Unit.

VITAMIN ASSAY METHODS

THE ASSAY of vitamins is a very active field of research. New methods are being devised, older methods abandoned. Biological assays are being replaced by more rapid chemical, physical and microbiological methods, but still remain as the base of official standards for many vitamins. Microbiological growth methods, which measure the growth of micro-organisms in nutrient solutions in which an excess of all but the vitamin being measured is present, have been used with most of the vitamins of the B-complex. Micro-technics are now available which make possible the analysis of small amounts of capillary blood.

Some of the current methods for the assay of vitamins are listed below:

Vitamin A

Biological

Rats are the animal of choice. Assay may be based on the prevention or cure of the deficiency signs. The most useful criteria for assay are: increase in weight of young animals (U.S.P. XIII method); eye lesions of xeropthalmia; rat liver storage of A; and abnormal estrus and keratinization of vaginal epithelial cells.

Chemical

As vitamin A—Saponification, separation from impurities by chromatographic adsorption and elution, and development of an evanescent blue color with antimony trichloride in chloroform (Carr-Price reagent) or with "activated" 1,3-dichloro-2-propanol. It is also determined spectrographically by the same purification, and measurement of the ultra-violet absorption at 300, 325 (A.O.A.C. method) and 350 millimicra.

As provitamin A (carotenes, cryptoxanthin, etc.)—Saponification if necessary, extraction, chromatographic adsorption-elution, and measurement of its yellow color at 450, 470, 480 millimicra (A.O.A.C. method); it may also be partitioned between aqueous diacetone alcohol and petroleum ether.

Thiamine

Biological

Rat growth (A.O.A.C. method); cure of bradycardia, and of polyneuritis (U.S.P. XIII method); chick growth; prevention and cure of deficiency signs (*e.g.*, retracted neck) in pigeons.

Microbiological

Acid and/or enzymatic hydrolysis, fermentation with yeast and measurement of CO_2 production (A.O.A.C. method); growth of *L. fermentum* 36 and measurement of turbidity. Various bacteria, yeasts and molds have also been used for this assay.

Chemical

Extraction, dephosphorylation, purification by adsorption-elution, coupling with various diazotized aromatic amines and measurement of color formed: conversion to thiochrome, extraction and measurement of blue-violet fluorescence (A.O.A.C. method).

Riboflavin

Biological

Increase in weight of young rats; prevention of curled toe paralysis in chicks.

Microbiological

Acid or enzymatic hydrolysis, ether extraction of fatty impurities, turbidimetric growth or titration fermentation measurements, using *L. casei* #7469 (U.S.P. XIII, A.O.A.C. method).

Chemical

Acid and/or enzymatic hydrolysis, oxidation of impurities with potassium permanganate, removal of excess with hydrogen peroxide, adsorption-elution and measurement of green fluorescence at 565 millimicra.

Acid hydrolysis, reduction of riboflavin and impurities, oxidation of reduced riboflavin by air, followed by fluorimetry (A.O.A.C. method).

Nicotinic Acid

Biological

No acceptable bioassay at present (because of the many dietary factors involved).

Microbiological

Acid or alkaline hydrolysis, titration of lactic acid produced by fermentation activity of *L. arabinosus* 17-5 (#8014) (U.S.P. XIII, A.O.A.C. method).

Chemical

Acid hydrolysis, decoloration, followed by reaction with cyanogen bromide and an aromatic amine (*e.g.* aniline, *alpha*-naphthyl amine, *p*-aminoacetophenone, etc.) to give a yellow color; condensation of N′-methylnicotinamide with acetal in alkaline solution to give a fluorescent pigment.

Pyridoxine

Biological

Growth of rats, mice, chicks; cure of acrodynia and dermatitis in deficient rats and mice.

Microbiological

Growth of yeast, *S. carlsbergensis* 4228, or mold (mutant of *Neurospora sitophilia*). Various bacteria have also been used for this assay.

Chemical

Reaction with 2,6-dichloroquinone-chloroimide to form a vitamin-indophenol compound, measured at 660 millimicra.

Pantothenic Acid

Biological

Rat or chick growth; prevention of chick dermatitis.

Microbiological

Enzymatic hydrolysis, followed by measurement of growth of *L. arabinosus* 17-5, *L. casei* #7469. The yeasts *S. carlsbergensis and Proteus morganii* have also been used.

Inositol

Microbiological

Enzymatic hydrolysis followed by measurement of the amount of growth of the yeast Y-915 by photoelectric determination of turbidity.

Chemical

Isolation and weighing of pure compound; titration with periodic acid.

Biotin

Microbiological

Enzymatic hydrolysis and growth of the yeast *S. cerevisiae* 139 or F. B.; bacteria, *L. arabinosus* Y-195; or mutant of the mold *N. crassa*. Various fungi and bacteria have also been used for this assay.

Folic Acid (Vitamin M Group)

Biological

Effect on blood regeneration rate of deficient monkeys, and ability to protect against nutritional cytopenia. Effect on growth and cure of anemia in chicks.

Microbiological

Hydrolysis and extraction with chick pancreas enzyme. Growth of *L. arabinosus* 17-5.

Choline

Microbiological

Preliminary separation of methionine from choline by adsorption and elution. Growth of a cholineless mutant of *Neurospora crassa*.

Chemical

Extraction with methanol and precipitation of the reineckate. Colorimetric analysis is made of an acetone solution at 525 or 327 millimicra.

Ascorbic Acid

Biological

Since guinea pigs can not synthesize vitamin C (as rats do) they are the animals of choice. Various criteria are chosen. These include the classical Sherman method; determination of the amount of C needed to protect against lameness or stiffness, and post-mortem examination for hemorrhages, beading of the ribs, fragility of bones and looseness of incisors. Other methods measure increase in weight, recovery of lost weight, effect on tooth structure, tooth growth, etc., and serum alkaline phosphatase.

Chemical

As ascorbic acid — Stabilization and visual titration with iodine or 2,6-dichlorophenol-indophenol (U.S.P. XIII, A.O.A.C. method); extraction of unreduced dye with xylene and correction for interfering substances (cysteine, hydrogen sulfide, metallic ions, reductones,etc.); oxidation to dehydro-ascorbic acid and coupling with 2,4-dinitrophenylhydrazine; polarograph.

As dehydro-ascorbic acid—Reduction to ascorbic acid with hydrogen sulfide, and titration with dye; coupling with 2,4-dinitrophenylhydrazine.

D Vitamins

Biological

Preparations intended for use in man are assayed on rats, those for birds are assayed on chickens. Although D_2 and D_3 appear to be of approximately equal potency for man, D_3 is considerably more effective than D_2 in promoting calcification in chicks. With rats the assay is based on the "line" test (U.S.P. XIII, A.O.A.C. method); the reappearance of a provisional zone of calcification in the epiphyseal cartilage of animals with severe rickets, whose cartilages had been rendered calcium-free by faulty diets. The bones are sectioned and stained with silver nitrate. Other criteria used are the appearance of a calcification zone in X-ray photographs, which is generally used as a curative test, and the determination of the percentage of ash in the dry, fat-extracted bone, which is generally used as a prophylactic test.

Preparations intended for poultry use are assayed on chicks. The line test cannot be used, for healing in chickens does not show itself as a line of calcification. The usual criteria are the percentage of bone ash in the tibia (A.O.A.C. method), or X-ray photography of the tibia and measurement of the tarsometatarsal distance.

Chemical

Reaction with antimony trichloride and acetyl chloride in chloroform, measured at 500 millimicra or by reaction with glycerol chlorohydrin and acetyl chloride in chloroform, measured at 625 millimicra.

Vitamin E

Biological

Rats—measurement of ability to prevent fetal death and resorption. The birth of a litter of one or more rats, alive or dead, is considered a positive response. Another endpoint, capable of showing a subminimal type of response, is to determine the weight of the uterine contents on the sixteenth day of pregnancy.

Chemical

Extraction, saponification, adsorption-elution, molecular distillation, catalytic hydrogenation, etc. Reaction with ferric chloride and α,α'-dipyridyl to form a red color measured at 522 millimicra.

Vitamin K

Biological

Chick, bile-fistula rats and dogs. Criterion chosen is the effect on blood clotting time, prothrombin time. Effect on blood prothrombin of chicks is the basis of the A.O.A.C. method.

Chemical

Various qualitative color tests are available, but no satisfactory quantitative methods.

General References

Association of Vitamin Chemists, Inc.: *Methods of Vitamin Assay*. Interscience, New York (1947).

Coward, Katharine, H.: *The Biological Standardization of the Vitamins* (2nd ed.). Bailliere, Tindall and Cox, London (1947).

Dann, W. J., and Satterfield, G. H.: *Estimation of Vitamins; Vol. XII of Biological Symposia*. Ronald Press, New York (1947).

Gyorgy, Paul (Ed.): *Vitamin Methods* (*Vol.I*). Academic Press, New York (1950).

Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists (6th ed.). A.O.A.C., Washington (1945).

The Pharmacopoeia of the United States of America, Fourteenth Revision, (*U.S.P. XIV*). United States Pharmacopoeial Convention, Washington (1950).

THE ESSENTIAL ELEMENTS

CALCIUM

Positive Functions

Most abundant mineral element in body.

An important constituent of bones and teeth.

Participates in blood coagulation (by activating conversion of prothrombin to thrombin).

Shares in the regulation of cardiac and uterine muscle action.

Important for capillary permeability.

Activator of many enzymes.

Essential for function of voluntary and autonomic nervous systems.

Participates in the maintenance of osmotic balance.

Deficiency Signs and Symptoms

May be caused by lowered parathyroid activity, excessive ingestion of oxalate or phytate or lowered intake of vitamin D.

Poor development of bones and teeth, osteoporosis, embrittlement, rickets, osteomalacia.

Excessive bleeding, delayed coagulation.

Low-calcium tetany.

Intestinal atony, inflammation of mucosa.

Hypertrophy of parathyroid.

Compounds Used in Therapy

Calcium gluconate.
Calcium carbonate.
Calcium chloride.
Calcium lactate.
Dicalcium phosphate.
Tricalcium phosphate.
Vitamin D.
Parathyroid extract.

Dietary Sources*

(Mg. per 100 g. of edible portion)

Almonds	254	Kale	225
Beans, common or kidney, dry	148	Milk, fresh, whole	118
Broccoli	130	Molasses, cane	273
Cheese	873	Mustard greens	220
Egg yolk	147	Olives, green	101
Ice cream, plain	132	Soybeans, whole	227
		Turnip greens	259

*Abstracted from U.S.D.A. Misc. Pub. #572.

CHLORINE

Positive Functions

Chief anion of extra-cellular fluid.

Aids in the regulation of osmotic pressure in blood and tissues.

Secreted as hydrochloric acid by gastric mucosa.

Shares in maintaining the acid-base balance of the blood.

Plays an important role in the maintenance of normal cardiac action.

Deficiency Signs and Symptoms

Retardation of growth, loss of body weight.
Renal lesions.
Poor water retention.
Impaired digestion.
Salt hunger, miner's cramps.
Achlorhydria.
Increased alkali reserve.
Hyperexcitability, convulsions.

Compounds Used in Therapy

Sodium chloride (table salt).

Other chlorides are used chiefly as a source of the cation.

Dietary Sources*

(Mg. per 100 g. of edible portion)

Bacon	1250	Flour, whole wheat	177
Bread, white	621	Heart	125
Cabbage	108	Kale	122
Celery	137	Kidney	246
Cocoa	1065	Liver	101
Coconut, dry	225	Milk, fresh	106
Corn meal	146	Olives	1877
Dates	283	Oysters	628
Eggs	120	Turkey	123
Figs, dried	105	Watercress	109
Flounder	151		

*Abstracted from "Chemistry of Food and Nutrition" (7th Ed.) by H. C. SHERMAN. The Macmillan Co., New York (1946).

COBALT

Positive Functions

Stimulates hematopoietic system.

A constituent of vitamin B_{12} [Rickes, E. L., *et. al.: Science* **108**, 134 (1948)].

Essential for ruminants. May promote synthesis of needed B-complex vitamins by rumen bacteria.

Excess causes polycythemia.

Deficiency Signs and Symptoms

Microcytic hypochromic anemia. (See p. 49.)

Significance for man not established.

Cobalt deficiency diseases of ruminants

Bush sickness, Morton Mains disease, Mairoa dopiness, enzootic marasmus, nutritional anemia, coast disease, Nakuruitis, "pining," Grand Traverse disease, "salt sick," etc., etc., are wasting diseases which affect sheep and cattle in various parts of the world. They have the common characteristic that they respond to cobalt therapy and, in general, have been traced to cobalt deficiencies in the soil and plants of the several regions.

Compounds Used in Therapy

Various salts, *e.g.*, the carbonate, chloride and sulfate. The form of the anion is not critical.

Cobalt Content of Plant Products*

(Micrograms per 100 g. of edible portion)

Apricots	3.2	Onions	13
Beans, wax	10	Pears	18
Beets, roots	5-9	Peas, green	3
Beets, tops	40	Potatoes, Irish	6
Buckwheat	36	Potatoes, sweet	2-3
Cabbage	7-24	Rice, polished	0.6
Carrots	2	Spinach	7-120
Chard, Swiss	9	Spinach, New Zealand	9
Cherries	0.5	Tomatoes	10
Corn	1-2	Turnip greens	3-107
Figs	20	Walnuts	5
Lettuce	100		

*See "Cobalt" by R. S. Young. A.C.S. Monograph No. 108. Reinhold Publishing Corp., New York (1948).

COPPER

Positive Functions

Necessary for the formation of red blood cells and hemoglobin in many species.

Necessary for cytochrome oxidase activity.

Constituent of oxidases, *e.g.*, ascorbic acid oxidase; needed for cell respiration.

Used as prophylactic agent against anemia of infancy.

Deficiency Signs

Microcytic hypochromic anemia. (See p. 49.)

Decreased cytochrome oxidase activity.

Achromotrichia.

Impaired growth and reproduction.

Poor utilization of iron.

"Falling disease" of cattle.

Endemic copper deficiency in sheep is associated with widespread myelin degeneration in their lambs.

Compounds Used in Therapy

Copper sulfate: copper sulfate in large doses, *i.e.*, 0.5 grams, acts as an emetic; the dose for anemia therapy in infants is of the order of 3 mg. per day. Up to 20 mg. per day can be ingested by adults without toxic symptoms.

Dietary Sources*

(Micrograms per 100 g. of edible portion)

Asparagus	141	Kale	328
Avocado	690	Liver	2450
Bananas	200	Mackerel	230
Beans, dry	960	Oats	738
Beans, Lima, dry	915	Oysters	3623
Beets	187	Peas, dried	802
Bread, white	205	Prunes, dried	291
Corn	449	Rye, whole	656
Eggs	253	Spinach	197
Flour, whole wheat	435	Sweet potatoes	184
		Wheat	787

*Abstracted from "Chemistry of Food and Nutrition" (7th Ed.) by H. C. Sherman. The Macmillan Co., New York (1946).

FLUORINE[1]

Positive Functions

Fluorine in concentrations of 1-1.5 mg. per liter in domestic water supplies may substantially decrease the incidence of dental caries.

Higher concentrations produce dental fluorosis (mottled enamel).

Lower concentrations have little or no caries-inhibiting value.

The direct addition of 1.0 mg. of fluorine to the daily diet of children during the first 8 years may also control caries. This supplement is contra indicated when the drinking water contains more than 0.5 mg. of fluorine per liter.

Maximum inhibition of caries occurs during the first twelve years of life.

Deficiency Signs and Symptoms

Higher incidence of dental caries.

Compounds Used in Therapy

Sodium fluoride by topical application or in municipal water supplies.

Fluorine salts are toxic; they should be used with a great deal of care.

Fluorine Content of Common Foods[2,3]

(Micrograms per 100 g. of edible portion)

Apples	80	Milk	7-22
Beef	200	Oats	70-170
Bread, rye	340	Pancreas	860
Bread, white	64	Potatoes	20
Butter	150	Salmon, canned	450
Cheese	160	Sardines, canned	730-1250
Codfish, fresh	700	Soupbone	9390
Egg yolk	80-120	Spinach	46-63
Fish, fresh water	160	Tomatoes	3-5
Kidney	860	Wheat	30-100
Lettuce	3-4	Wheat germ	150-350
Liver	150-160		

1. See "Dental Caries and Fluorine"—edited by F. R. MOULTON, American Association for the Advancement of Science, Washington (1946).
2. For original sources of these analyses see "Fluorides in Food and Drinking Water," Natl. Inst. of Health Bulletin #172 (1939) by F. J. MCCLURE.
3. The fluorine content of vegetables reflects that of the soil in which they are grown, and the water used to prepare them.

IODINE

Positive Functions

Regulates function and size of thyroid gland by its reaction with tyrosine to form di-iodotyrosine, which yields thyroxin.

Thyroxin participates in the regulation of—

- Growth
- Maturation
- Differentiation of tissue
- Water balance
- Carbohydrate metabolism
- Nervous system
- Muscular system
- Circulatory system
- Reproductive system
- Other endocrine glands

Deficiency Signs and Symptoms

Simple goiter (epithelial hyperplasia type).

Endemic cretinism.

Subnormal basal metabolic rate.

Lowered mental and physical activity.

Low fertility.

Compounds Used in Therapy

Sodium or potassium iodide.

Iodized salt (0.01% KI).

Various thyroid or thyroxin preparations.

Dietary Sources

Iodized salt has been approved for general use in foods by the Committee on Foods of the American Medical Association. "*There seems now to be a consensus . . . that iodized salt can be made a satisfactory means of supplying the nutritional need for iodine. Obviously, then, to the extent that iodized salt is utilized, the iodine content of foods becomes a matter of abstract scientific interest rather than practical dietetic anxiety. Yet so long as there remain regions in which the iodine content of the drinking water is low and the use of iodized salt is not practically universal, cases may sometimes occur in which the adequacy of the iodine intake depends upon the choice and source of the food.*"*

*H. C. SHERMAN, in "Chemistry of Food and Nutrition," (7th Ed.), p. 318. The Macmillan Co., New York (1946).

IRON

Positive Functions

Formation of the oxygen carriers, hemoglobin and myoglobin.

Formation of oxidizing catalysts, cytochrome, catalase, peroxidase.

Formation of "storage iron," hemosiderin.

Ferrous form more readily absorbed by man.

Deficiency Signs and Symptoms

Microcytic hypochromic anemia—may occur from *chlorosis* (inadequate intake), *achlorhydria* (impaired absorption), *pregnancy* or *childhood* (increased need), *hemorrhage* from gastrointestinal tract, *menstruation* (excessive loss). (See p. 49.)

Compounds Used in Therapy

Ferrous sulfate.
Ferrous gluconate.
Iron and ammonium citrate.
Sodium iron pyrophosphate.
Reduced iron.

Dietary Sources[1, 2]

(Mg. per 100 g. of edible portion)

Almonds	4.4	Eggs, whole fresh	2.7
Beans, canned baked	3.4	Flour, wheat, enriched	2.9
Beans, common or kidney, dry	10.3	Heart, fresh	6.2
Beans, Lima, dry	7.5	Lamb	2.6
Beef	2.4-4.0	Liver, fresh	12.1
Beef, dried or chipped	4.1	Liver sausage	5.4
Beet greens	3.2	Molasses, cane	6.7
Bread, whole wheat	2.6	Oatmeal	5.2
Chard	4.0	Oysters	7.1
Cornmeal, whole germ	2.7	Peas, split	6.0
		Pork	2.2-2.5
		Rice, brown	5.5
		Soybeans	8.0
		Spinach	3.0

1. Abstracted from U.S.D.A. Misc. Pub. #572.
2. Not all of the iron in the above foodstuffs is equally available to the body. At present, the determination of "availability" varies considerably, and we are following the precedent set by U.S.D.A. Misc. Pub. #572, and R. A. McCance and E. M. Widdowson in the 2nd edition of their "Chemical Composition of Foods" (p. 8) by omitting data on the "availability" of iron in foods.

MAGNESIUM

Positive Functions

Essential for functional integrity of neuromuscular system.

Necessary to maintain normal structure of growing tissue.

Activates phosphorylytic enzymes.

Participates in bone formation.

Antacid and cathartic.

Deficiency Signs and Symptoms

Renal lesions.

Hyperirritability.

Tonic and clonic convulsions, tetany.

Tachycardia, sinoauricular block.

Vasodilatation.

Changes in teeth and bones.

Degenerative changes in the Purkinje cells of the cerebellum (chicks).

Chemical Compounds Used in Therapy

Magnesium compounds are used principally for their effect on the gastrointestinal tract.

As laxatives

Magnesium citrate, magnesium sulfate.

As antiacids

Magnesium hydroxide (milk of magnesia), magnesium carbonate, magnesium trisilicate.

Dietary Sources*

(Mg. per 100 g. of edible portion)

Almonds	252	Hazelnuts	140
Barley, entire	171	Oatmeal	145
Beans, Lima, dry	181	Peanuts	167
Beet greens	113	Peas, fresh	140
Brazil nuts	225	Pecans	152
Cashew nuts	267	Rice, brown	119
Cocoa	420	Soy flour	223
Corn	121	Walnuts	134
Flour, whole wheat	122	Wheat, whole	165

*Abstracted from "Chemistry of Food and Nutrition" (7th Ed.) by H. C. Sherman. The Macmillan Co., New York (1946).

MANGANESE

Positive Functions

Essential for growth, reproduction and lactation.

Activates many enzyme systems, *e.g.*, phosphatases, cozymase, carboxylase, cholinesterase.

Helps hemoglobin synthesis.

Component of arginase.

Necessary for thiamine utilization and storage.

Manganese requirements of fowl are much higher than those of mammals.

Tends to prevent deposition of liver fat.

Deficiency Signs and Symptoms

Perosis (slipped tendon) in fowl.

Growth disturbance in young of deficient mothers (rabbits, rats, mice).

Loss of testicular function.

Osteoporosis, decreased alkaline phosphatase.

Ataxia, incoordination and loss of equilibrium.

Lowered liver arginase activity (rodents).

No evidence for manganese deficiency in man has yet been cited.

Compounds Used in Therapy

Manganous chloride.

Mangagous sulfate.

Potassium permanganate (powerful oxidizing agent used as an antiseptic or antidote).

Dietary Sources*

(Micrograms per 100 g. of edible portion)

Bananas	640	Liver	391
Beans, dry	1500	Oatmeal	4945
Beans, snap	325	Onions	363
Beets	575	Peas, dried	1990
Corn, whole	680	Prunes, dried	436
Flour, white	710	Rice, white	1014
Flour, whole wheat	4300	Rye, whole grain	3067
Kale	590	Spinach	828
Lettuce	1240	Sweet potatoes	407
		Wheat	4591

*Abstracted from "Chemistry of Food and Nutrition" (7th Ed.) by H. C. Sherman. The Macmillan Co., New York (1946).

POTASSIUM

Positive Functions [1]

"Potassium is of the soil and not the sea; it is of the cell but not the sap."[1]

Chief cation of intracellular fluid.

Necessary for cardiac action, transmission of the nerve impulse, and musular contraction.

Excitatory in small concentrations, inhibitory in larger. These effects are usually inhibited by the presence of calcium ions.

Necessary for growth.

Activates enzyme reactions, *e.g.*, the phosphorylation of creatine.

Deficiency Signs and Symptoms

Retardation of growth.

Myocardial lesions.

Necrosis of renal tubular epithelium.

Hyperexcitability.

Hypokalemia, low blood potassium, has been reported in sprue, infant diarrhea, Addison's disease treated with desoxycorticosterone, steatorrhea, prolonged alimentation with intravenous fluids, chronic nephritis and during the post acidotic states of diabetic coma.

Compounds Used in Therapy

Potassium chloride.

Most salts of potassium are used in therapy for the action of the anion.

Dietary Sources [2]

(Mg. per 100 g. of edible portion)

Almonds	710	Oatmeal	340
Apricots, dry	1700	Olives, green	55
Avocado	340	Parsnips	740
Barley	160	Peanuts	700
Beans, dried	1300	Peas, dry	880
Broccoli	400	Potatoes	410
Chesnuts	410	Prunes, dry	600
Cocoa	1400	Raisins	720
Coconut, dry	770	Soy flour	1700
Dates	790	Spinach	780
Figs, dried	780	Walnuts	450
Molasses	1500	Wheat, whole	370

1. W. O. Fenn: *Physiol. Rev.* **20**, 377 (1940).
2. For further analyses see Bills, C. E. *et al.*: *J. Am. Diet. Assoc.* **25**, 304 (1949).

PHOSPHORUS

Positive Functions

Essential constituent of all cells.

Constituent of various enzymes, *e.g.*, cocarboxylase, flavo-proteins, phosphopyridine nucleotides.

Essential for protein metabolism, *e.g.*, nucleic acids, creatinine, adenosine triphosphate, adenosine diphosphate.

Formation of phospholipids (lecithin, cephalin).

Participates in the carbohydrate cycle and muscle metabolism.

Needed for normal bone and tooth structure.

Interrelated with actions of calcium, vitamin D, and the parathyroid hormone.

Deficiency Signs and Symptoms

Rickets, osteomalacia.

Growth retardation.

Calcium citrate calculi in kidneys, ureter, and bladder.

Compounds Used in Therapy

Dicalcium phosphate.
Lecithin.
Phosphoric acid (diluted).
Sodium metaphosphate.
Sodium acid phosphate.

Dietary Sources [1, 2]

(Mg. per 100 g. of edible portion)

Almonds	475
Beans, dry	463
Beans, Lima, dry	380
Beans, Lima, green	158
Beef	167-208
Beef, dried, chipped	376
Bread, whole wheat	270
Cheese, hard	610
Cheese, cottage	263
Chicken	218
Corn, sweet	120
Cornmeal, whole grain	248-276
Eggs, whole fresh	210
Fish, various species	218
Flour, rye, whole grain	369
Flour, whole wheat	385
Heart, fresh	236
Liver, fresh	373
Milk, fresh, whole	93
Oatmeal	365
Peanuts, peanut butter	393
Peas, split	397
Peas, green	122
Pecans	324
Pork	157-182
Rice, brown	303
Rice flakes, puffed rice	365
Sardines, canned	365
Salmon, canned	286
Soybeans, whole	586
Tuna fish, canned	290
Turkey	320
Veal	200
Wheat, whole	385

1. Abstracted from U.S.D.A. Misc. Pub. #572, and;
2. "Chemistry of Food and Nutrition" (7th Ed.) by H. C. SHERMAN. The Macmillan Co., New York (1946).

Ubiquitous Elements of Unknown Function

The elements listed in detail are those known to be essential for at least one animal species. Chemical analysis reveals that a number of other elements are present in the organism. Some of these may be found to be indispensable; most are probably fortuitous. These elements include: aluminum, arsenic, barium, boron, bromine, cesium, lead, lithium, rubidium, silicon, strontium, tin, and titanium.

SODIUM

Positive Functions

Chief cation of extra-cellular fluid.

Shares in the regulation of osmotic pressure and water balance in the body.

Pharmacologically inert.

Helps maintain acid-base balance.

Low sodium diet used in treating hypertension.

Increased need for sodium in adrenal cortical insufficiency.

Sodium chloride solutions are used as diuretics except in cases of clinical edema.

Deficiency Signs and Symptoms

Ocular lesions in rats.
Retardation of growth.
Dehydration, hemoconcentration.
Anorexia, nausea, fatigue.
Muscle cramps.

Compounds Used in Therapy

Sodium bicarbonate, chloride, or lactate.

Other sodium salts are used for the action of the anion.

Sodium Content of Foods [1, 2, 3]

FOOD	SODIUM mg./100 g.
Apple, less skin and core	0.2
Asparagus, tips	2
Banana	0.5
Beans in pods	0.9
Beef, lean	51
Beet	110
Bread, rye and wheat	590
Bread, white, enriched	640
Broccoli	16
Butter, average salted—Theoretical value based on U.S. average salt content of 2.5%	980
Cabbage	5
Carrots, scraped and trimmed	31
Cauliflower, bud	24
Cheese, cheddar	700
Cheese, cottage	290
Cheese, process	1,500
Chicken, breast meat	78
Chicken, leg meat	110
Clam	180
Cod	60
Cornmeal, yellow, enriched, degerminated	0.7
Corn oil	0.2
Corn, sweet white, milk stage	0.3
Cream, whipping (32% fat)	40
Cucumber, less parings	0.9
Egg	81
Egg, whites only	110
Egg, yolks only	26
Fruit cocktail, canned in sirup	9
Lamb chop, lean	98
Lamb, leg, lean	78
Milk, whole, liquid	50
Oats, rolled	2
Oleomargarine	1,100
Onion, less tops and dry skins	1
Oyster, fresh	73
Peas, fresh	1
Peach, less skin	0.5
Peanut butter	120
Pear, Bartlett, less skin and core	2
Pineapple	0.3
Pork, lean	58
Prune juice, unsweetened, bottled	2
Salmon, canned	540
Salt, common—Theoretical value for pure NaCl	39,342
Spinach	82
Squash, acorn, less rind and seeds	0.4
Tomato, with skin	3
Turnip, white, less skin and tops	37
Turnip, yellow (rutabaga), less skin and tops	5
Wheat germ, with some bran and flour	2

1. *J. Am. Dietetic Assoc.* **25**, 304 (1949).
2. Unless otherwise stated, all analyses were made on the edible portion of unprocessed foods.
3. We are indebted to Dr. Charles E. Bills, Research Director of Mead Johnson and Company, and to the *Journal of the American Dietetic Association* for permission to reprint the above sodium analyses. They represent only a small portion of the values that Dr. Bills has obtained.

SULFUR

Positive Functions

Is a constituent of:

Amino acids (methionine, cystine).
Hormones (insulin).
Vitamins (thiamine, biotin).
Lipids (sulfatides).
Enzymes.

By formation of –S-S– and –SH linkages participates in oxidation-reduction processes.

Deficiency Signs and Symptoms

Deficiency signs are caused by inadequate intake of the sulfur-containing amino acids methionine and/or cystine (see p. 38).

Methionine deficiency may cause:

Anemia.
Hypoproteinemia.
Hemorrhagic necrosis of the liver.
Inhibition of hair growth.
Negative nitrogen balance.

Compounds Used in Therapy

Methionine and/or cystine.

Inorganic sulfur cannot be used to form or replace the sulfur-amino acids; it is retained chiefly by the bone marrow, bone and cartilage.

Dietary Sources [1,2]

(Mg. per 100 g. of edible portion)

Beans, dried	237	Ham	225
Beef, lean	230	Heart	296
Bluefish	241	Lamb	211
Brazil nuts	198	Liver	251
Brussels sprouts	184	Oatmeal	199
Cheese, hard	218	Peanuts	226
Chicken	252	Peas, dry	196
Clams	219	Pork	206
Cocoa	203	Salmon	226
Codfish	203	Turkey	234
Eggs, whole fresh	197	Veal	203

1. Abstracted from "Chemistry of Food and Nutrition" (7th Ed.) by H. C. Sherman. The Macmillan Co., New York (1946).
2. Some foods, such as certain dried fruits, are treated with sulfur dioxide during their preparation for market. Such material may contain appreciable amounts of sulfur which is unavailable to the body.

ZINC [1]

Positive Functions

Is an active component of the carbonic anhydrase molecule.

Excess dietary zinc may produce fibrosis of the pancreas and a hypochromic anemia.

Necessary for normal growth.

Deficiency Signs and Symptoms

Retarded growth.
Alopecia.
Lesions of skin, esophagus, and possibly cornea.
Disturbed carbohydrate and protein metabolism.
Lowered serum and intestinal alkaline phosphatase.

Because of the wide distribution of zinc in foods, it is improbable that zinc deficiency ever occurs in man.

Compounds Used in Therapy

Zinc acetate.
Zinc chloride.
Zinc sulfate.

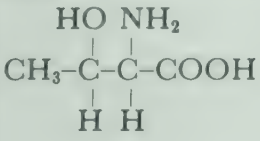
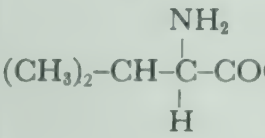
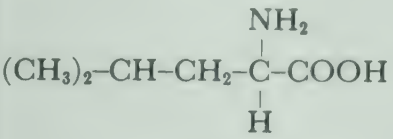
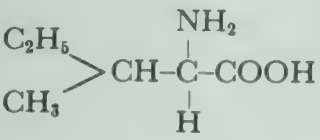
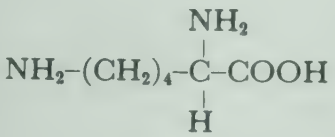
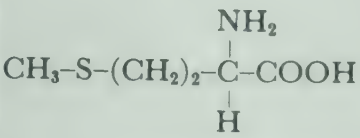
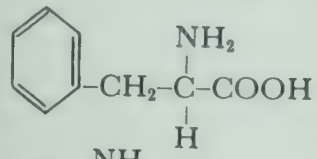
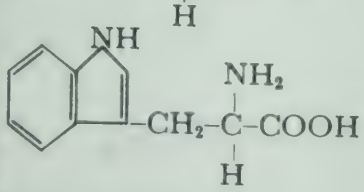
Zinc salts are employed in therapeutics solely for their local actions; they are used as astringents and mild antiseptics.

Dietary Sources*[2]

(Milligrams per 100 g. of edible portion)

Barley	2.7	Milk, cow	0.4-3.0
Beef	2-5	Oats, rolled	3-5
Beets	2.8	Oranges	0.1
Butter	0.3	Oysters	29-40
Cabbage	0.2-1.5	Peanut Butter	2.0
Carrots	0.5-3.6	Peas	3-5
Clams	2.0	Potatoes	0.2
Corn, whole	2.5	Rice	1.5
Egg yolk	2.6-4	Spinach	0.3-0.9
Lettuce	0.1-0.7	Wheat	2.5-8.5
Liver, beef	3.5-8.5	Wheat bran	14

1. See the review by Vallee, B. L. and Altschule, M. D.: *Physiol. Rev.* **29**, 370 (1949).
2. Abstracted from the following articles:
   Fairhill, L. T.: *J. Biol. Chem.* **70**, 495 (1926).
   Hubbel, R. B., and Mendel, L. B.: *J. Biol. Chem.* **75**, 567 (1927).
   Lutz, Robert E.: *J. Ind. Hyg.* **8**, 177-297 (1926).

NAME	FORMULA	FORMS GLYCOGEN[2]	FORMS KETONES[2]	UNNATURAL ISOMER UTILIZED
Threonine		3	0	0
Valine		3	0	0
Leucine		0	4	0
Isoleucine		+	4	?+
Lysine		0	0	0
Methionine		0	0	+
Phenylalanine		?	4	+
Tryptophane		0	0	0

1. Needed for maintenance of nitrogen equilibrium in young men. For maximum growth in the young rat histidine and arginine are also required; the latter is not needed for survival of the rat, however.
2. Number of carbon atoms undergoing conversion. BALDWIN, "Dynamic Aspects of Biochemistry," p. 212. Macmillan Co., New York (1947).
3. ROSE, W. C.: "Amino Acid Requirements of Man"; *Fed. Proc.* **8**, 546 (1949).
4. For a 70 kilo. man.
5. Based on average of U. S. diet. BLOCK, R. J., and BOLLING, D.: *J. Am. Diet. Assoc.* **20**, 69 (1944).
6. Cystine + methionine.
7. ROSE, W. C., and EPPSTEIN, S. H.: *J. Biol. Chem.* **127**, 677-84 (1939).

AMINO ACIDS[1]

UPPER LIMITS OF DAILY NEEDS[3, 4] (Tentative Values, Grams)		AVERAGE DAILY INTAKE[5] g.	SPECIAL FUNCTIONS
Minimum	Recommended		
0.50	1.0	3.6	
0.80	1.6	3.9	Deficiency in rats causes hyperesthesia and muscular incoordination.[7]
1.10	2.2	12.6	Deficiency in rats causes enlargement of hypophysis and corneal vascularization.[8]
0.70	1.4	3.7	
0.80	1.6	5.2	Deficiency in humans causes nausea, dizziness, and anemia.[9] In rats—corneal vascularization.[10]
1.10	2.2	4.1[6]	Donates labile methyl groups and organic sulfur. Deficiency in rats causes corneal vascularization,[11] anemia and hypoproteinemia.[12]
1.10	2.2	4.7	Source of benzene ring for biosyntheses. Through tyrosine forms melanin, epinephrine, and thyroxin.
0.25	0.5	1.1	Inter-related with the action of niacin,[13] pyridoxine.[14] Tryptophane deficiency in rats produces aspermogenesis and cataracts.[15]

8. Maun, W. E., *et al.: Arch. Path.* **40**, 173 (1945).
9. Albanese, A. A., *et al.: Proc. Soc. Exp. Biol. & Med.* **48**, 728 (1941).
10. Sydenstricker, V. P., *et al.: Fed. Proc.* **4**, 155 (1945).
11. Sydenstricker, V. P., *et al.: Science* **103**, 194-196 (1946).
12. Glynn, L. E., *et al.: Brit. J. Exp. Path.* **26**, 326 (1945).
13. Krehl and associates (rats and dogs), Dann (rats), Briggs (chicks), Woolley (chicks), and Hundley (dogs). For references see Hundley, J. M.: *J. Nutrition* **34**, 253-62 (1947).
14. Lepkovsky, S., and Nielsen, E.: *J. Biol. Chem.* **144**, 135 (1942).
15. Albanese, A. A., and Buschke, W.: *Science* **95**, 584 (1942).

ESSENTIAL AMINO ACID COMPOSITION OF PROTEIN FOODS[1, 2, 3, 4]

	G. Protein per 100 g.	%N in Protein	Threonine	Valine	Leucine	Iso-Leucine	Lysine	Methionine	Phenyl-alanine	Trypto-phane
Egg, whole	12.8	14.1	**554** (4.9)	**497** (4.4)	**2,150** (19.0)	**598** (5.3)	**1,030** (7.5)	**450** (3.3)	**660** (4.8)	**210** (1.5)
Casein	89.0	12.2	**2,650** (3.9)	**4,750** (7.0)	**8,200** (12.4)	**4,410** (6.5)	**4,680** (6.9)	**2,380** (3.5)	**3,530** (5.2)	**1,220** (1.8)
Milk, whole, cow	3.5	15.2	**153** (4.6)	**250** (6.8)	**340** (9.2)	**220** (6.0)	**249** (7.5)	**93** (2.7)	**190** (5.2)	**63** (1.4)
Milk, whole, human[5]	1.4	15.2	**61** (4.6)	**73** (5.5)	**161** (12.1)	**69** (5.2)	**96** (7.2)	**27** (2.0)	**79** (5.9)	**25** (1.9)
Meat, animal muscle	18.0	16.1	**960** (5.3)	**615** (3.4)	**2,190** (12.1)	**615** (3.4)	**1,380** (7.6)	**580** (3.2)	**700–900** (4–5)	**218** (1.2)
Fish, muscle[6]	19.0	16.0	**835** (4.4)	**990** (5.2)	**1,430** (7.5)	**950** (5.0)	**1,580** (8.3)	**550** (2.9)	**720** (3.8)	**170** (0.9)
Liver, animal	19.8	13.3	**955** (5.8)	**1,270** (6.5)	**1,840** (9.3)	**940** (4.8)	**1,040** (6.3)	**527** (3.2)	**1,200** (7.3)	**246** (1.5)
Wheat, whole	13.0	....	**455** (3.3)	**496** (3.6)	**800** (5.8)	**455** (3.3)	**372** (2.7)	**220** (1.7)	**785** (5.7)	**138** (1.0)
Wheat, germ, defatted	28.5	....	**1,080** (3.8)	**850–1400** (3.5)	**1400–1900** (5–9)	**850** (3.0)	**1,570** (5.5)	**570** (2.0)	**1,200** (4.2)	**285** (1.3)

Bread, white	8.5	11.3	**168** (2.8)	**168** (3.1)	**540–780** (9–13)	**168** (2.8)	**168** (2.8)	**120–180** (2–3)	**306** (5.1)	**78** (1.3)
Corn, whole	10.0	12.8	**290** (3.6)	**370** (4.6)	**1,500–1,900** (19–24)	**288** (3.6)	**200** (2.5)	**100** (2.6)	**360** (4.5)	**48** (0.6)
Corn germ, defatted	20.2	12.8	**710** (4.4)	**935** (5.8)	**2,100-3,080** (13-19)	**600** (3.7)	**935** (5.8)	**370** (2.3)	**900** (5.6)	**210** (1.3)
Oats, whole	14.6	12.8	**410** (3.5)	**760** (6.5)	**930** (8.0)	**620** (5.3)	**385** (3.3)	**270** (2.3)	**805** (6.9)	**152** (1.3)
Rice, whole	7.6	12.8	**237** (3.9)	**390** (6.4)	**468** (7.7)	**310** (5.1)	**194** (3.2)	**208** (3.4)	**385** (6.3)	**79** (1.3)
Soybean meal	48.7	....	**1,340** (4.0)	**1,400** (4.2)	**2,210** (6.6)	**1,570** (4.7)	**1,810** (5.4)	**670** (2.0)	**1,910** (5.7)	**535** (1.6)
Peanut flour	56.8	10.4	**555** (1.5)	**1,480** (4.0)	**2,040** (5.5)	**1,260** (3.4)	**1,110** (3.0)	**330** (0.9)	**2,000** (5.4)	**370** (1.0)
Cottonseed meal	45.0	10.9	**920** (3.0)	**1,130** (3.7)	**1,530** (5.0)	**1,040** (3.4)	**830** (2.7)	**490** (1.6)	**2,080** (6.8)	**400** (1.3)

1. Bold face figures are the milligrams of essential amino acid provided by 100 g. of the food.
2. Figures in parentheses represent percentage of the amino acid in the food protein. Corrected on the basis of an ideal protein containing 16 per cent of nitrogen on a moisture- and ash-free basis.
3. These values are only approximations. They are based on average figures for the foods involved. Considerable variation from these figures is to be expected, caused by analytical errors, species differences, and processing methods.
4. The values for amino acid content used in calculating these figures are taken from the Summary Tables, pp. 299-306 of "The Amino Acid Composition of Proteins and Foods," by R. J. Block and D. Bolling, Charles C. Thomas, Springfield, Illinois (1945); and from Texas Agricultural Station Bulletin 708, *The Amino Acid Composition of Meat and Some Other Foods*, by C. M. Lyman and K. A. Kuiknen (1949).
5. Considered by Block and Bolling to represent the best balanced protein.
6. Elvehjem, C. A., *et al.*: *J. Nutrition* **39**, 177, 187 (1949).

BIOLOGICAL VALUE[1] OF FOOD PROTEINS FOR HUMAN ADULTS[2]

Whole egg....78[3]	Soy flour....65	Corn meal....43
Milk....74	Rolled oats....60	Peanut flour....42
Meat....72	Whole wheat....55	White flour....41

1. The term "biological value" is used to express the percentage of absorbed nitrogen that is retained by the animal for growth and maintenance.
2. Reproduced from "Proteins and Amino Acids in Nutrition" (MELVILLE SAHYUN, Ed.) (1948), Chapter 2, "The Biological Utilization of Proteins and Protein Requirements," by H. H. MITCHELL, p. 65, with the permission of the editor, author and Reinhold Publishing Corporation. We commend this book to the attention of anyone interested in the subject of proteins.
3. Properly prepared whole egg, at low levels of intake, may approximate a biological value of 100.

Estimates of the Protein Requirements of Adult Man for the Maintenance of Nitrogen Equilibrium[1]

PROTEIN SOURCE	Protein Requirement (g.) N x 6.25 per 70 kilo.[2]	PROTEIN SOURCE	Protein Requirement (g.) N x 6.25 per 70 kilo.[2]
Whole wheat bread	66.8	All-vegetable diet[5]	32.4
Beef	26.3	Vegetable protein 2/3; meat protein 1/3[6]	27.1
Potato	29.6	Whole egg	19.9
Wheat flour	38.4	Beef steak	19.2
Milk	24.4	Haddock	21.6
White flour	42.1	Corn germ	20.7
Soy flour	25.4	Cottonseed flour	23.0
Soy-white flour[3]	29.8	Yeast	24.0
Mixed diet[4]	27.6		

1. Reproduced from "Proteins and Amino Acids in Nutrition," (MELVILLE SAHYUN, Ed.), Reinhold Publishing Corp., 1948, Chapter 2, by H. H. MITCHELL, p. 75, by permission of the editor, author, and publisher.
2. With a surface area of 1.8 square meters.
3. Containing 36 per cent soy flour protein and 64 per cent white flour protein.
4. Mixture of foods modified from list 1 proposed by the Food and Nutrition Board of the National Research Council (Circular 115, 1943). The diet contains about 47 per cent of animal protein.
5. Distribution of nitrogen: 50 per cent from white flour, 12 per cent from other cereal products, 13 per cent from potatoes, 17 per cent from other vegetables, and 8 per cent from fruits.
6. The amount of each food in the all-vegetable diet described above was increased by one-third and sufficient meat added to supply approximately the amount of nitrogen thus removed.

CONDITIONING FACTORS IN NUTRITIONAL DISEASE*

Factors Interfering with Ingestion

Gastrointestinal disorders

Acute gastroenteritis, gall bladder disease, peptic ulcers, diarrheal diseases and obstructive lesions of gastrointestinal tract.

Neuropsychiatric disorders

Neurasthenia, neurosis, psychoses, migraine, and neurologic disorders interfering with self feeding.

Loss of appetite

Alcohol, operations, anesthesia, infectious diseases, congestive heart failure, thiamine deficiency, visceral pain, pregnancy.

Loss of teeth

Therapy

Diets restricting ingestion of essential foods, as in food allergy.

Factors Interfering with Absorption

Fat-soluble vitamins

In all diseases where the absorption of fat is impaired, absorption of vitamin A and vitamin A-active carotenoids is diminished. These diseases include celiac disease, sprue, fibrosis and cystic disease of the pancreas, congenital atresia of the bile ducts, intestinal obstruction, ulcerative colitis, dysentery and diarrhea.

In general, absorption of vitamins D, E and K is influenced by the same factors that affect vitamin A.

Water-soluble vitamins

Anatomical, chemical or physiological changes in the gastrointestinal tract. These changes are mediated by reduced absorbing surfaces, altered secretions, and hypermotility, and further modified by various alkalies, adsorbents and lubricants introduced by mouth.

Minerals

Calcium absorption is governed by vitamin D, the pH of the intestine and other substances in the diet. It may be impaired by several materials commonly ingested in foods. Examples of these include oxalic acid (as in spinach), phytic acid (inositol-hexaphosphoric acid) and sodium phytate, and excessive amounts of phosphorus, iron, magnesium or potassium.

Phosphorus absorption is diminished by factors which favor the formation of poorly soluble salts of phosphoric acid. Beryllium, by forming insoluble beryllium phosphate, is the most effective of these. Other ions having this effect include calcium, strontium, manganese, barium, aluminum, thallium and iron.

Iron absorption is hampered by high pH in the duodenum, absence of free hydrochloric acid and of bile, phosphates and phytic acid.

Factors Causing Destruction or Inactivation of Vitamins

Several water-soluble vitamins are readily inactivated in the gastrointestinal tract prior to absorption. Thiamine may be destroyed by an elevated pH of the gastric juice, as in achlorhydria. Vitamin E and carotene may be inactivated by rancid fats.

Substances present in certain foodstuffs contain agents that may inactivate or destroy B-complex vitamins.

Certain fresh-water fish contain an enzyme, thiaminase, which destroys thiamine. When eaten raw they may induce a condition known as Chastek paralysis, curable by the administration of thiamine.

Raw egg white contains a protein, avidin, which combines with biotin and renders it unavailable, presumably by preventing its absorption. This may precipitate a biotin deficiency.

*Based on "Conditioned Malnutrition" by JOLLIFE, N.: *J.A.M.A.* **122**, 299 (1943); and "Conditioning Factors in Nutritional Disease" by ERSHOFF, B.: *Physiol. Rev.* **28**, *107* (1948).

Factors Interfering with Utilization

Malnutrition denotes a deficiency of essential nutrients in the tissue cells, rather than in the diet. Therefore, any factor interfering with the utilization of an essential nutrient may produce a deficiency despite the composition of the diet or the adequacy of digestion or absorption.

Impaired efficiency of conveyance

Absence of a suitable specialized carrier (*e.g.*, the appropriate lipid, phospholipids or protein) for the fat-soluble vitamins.

Impaired mechanism of acceptance

Certain tissues are able to concentrate specific nutrients from the blood or lymph prior to use. Examples include; iodine—thyroid, vitamin C—adrenals, vitamin A—liver, vitamin E—heart muscle and mammary gland, riboflavin—liver and kidney. Failure of this selective uptake hampers utilization.

Inadequate conversion of essential nutrients into active physiological components

Hepatic dysfunction, from cirrhosis or other causes, may result in impaired conversion of carotene to vitamin A, thiamine to cocarboxylase, riboflavin to flavoprotein and nicotinic acid to coenzymes I or II.

Protein deficiency may interfere with the synthesis of flavin-adenine-dinucleotide.

Antagonistic structural analogues

See table and discussion on next page.

Factors that Increase Excretion

Increased fluid output, as in polyuria, lactation, forcing of fluids, and excessive perspiration, may accentuate existing deficiencies.

Various drugs used as therapeutic agents may increase the excretion of vitamin C. Certain foodstuffs also have this effect.

Excessive protein loss may occur from hemorrhage, operations and injuries, gastrointestinal obstructions, burns, proteinuria, and continuous drainage of pus.

Factors Increasing Body Requirements (Stress Factors)

Increased metabolism

The requirement for many dietary essentials is proportional to the metabolic rate. There is an increased need for these factors in such conditions as hyperthyroidism, pyrexia and strenuous physical exertion.

Pregnancy and lactation

These may significantly increase body requirements. These requirements reflect increased metabolism, increased utilization in the formation of fetal or placental tissue, and increased secretion as milk.

Detoxification

Requirements for methionine and other nutrients may be significantly increased following exposure to various drugs, chemicals and other toxic agents. Although the specific mechanisms involved are obscure, the net result is that certain toxic or deleterious effects may be alleviated by increased amounts of specific nutrients.

Anoxia

The therapy of shock and anoxia may require vitamin supplementation, particularly with thiamine, nicotinic acid and riboflavin.

Miscellaneous factors

The thiamine requirement is proportional to the carbohydrate consumption. Various irritants, such as strong sunlight or trauma, may precipitate the typical skin lesions of nicotinic acid deficiency, and hasten the onset of corneal vascularization in riboflavin deficiency.

ANTAGONISTIC STRUCTURAL ANALOGUES OF VITAMINS*

Certain compounds closely related in structure to various vitamins are capable of producing the characteristic signs of vitamin deficiencies. These may be erased by increasing the dietary intake of the vitamin concerned. Study of the competition between structurally similar metabolites is useful in the experimental investigation of biochemical mechanisms.

Metabolite	Analogue	Structural Alteration
Thiamine	Pyrithiamine	CH=CH for S
	Oxythiamine	OH for NH_2
	Butylthiamine	Butyl for CH_3
Nicotinic Acid (or Amide)	Pyridine-3-sulfonic acid (or amide)	SO_3H for COOH
	3-acetyl pyridine	$COCH_3$ for COOH
	5-thiazole carboxamide	S for CH=CH
Riboflavin	6-7-dichloro-riboflavin	2 Cl for 2 CH_3
	Isoriboflavin	Shift in position of CH_3
	Galactoflavin	Dulcityl for ribyl
	Araboflavin	Inversion of position of OH
Pyridoxine	Desoxypyridoxine	H for OH
Pantothenic Acid	Thiopanic acid (pantoyl taurine) and derivs.	SO_3H and derivative for COOH
	Pantothenyl alcohol	CH_2OH for COOH
	α, β, or γ-methyl pantothenic acid	CH_3 for H
Inositol	Hexachlorocyclohexane	6 Cl for 6 OH
Biotin	Desthiobiotin and derivs.	2H for S
	Desthioisobiotin	Loss of S, geometric isomerism
	Biotin sulfone	SO_2 for S
Choline	Triethyl choline	3 ethyls for 3 methyls
Folic Acid	7-methyl folic acid	Methylation
Para-aminobenzoic Acid	Sulfonilamide and derivs.	SO_2NH_2 or derivative for COOH
	Carbarsone and related arsenicals	*As* for C in a COOH group
Vitamin K	Dicoumarol and derivs.	O for C, side chain changes
	α-tocopherol quinone	2 CH_3 for benzene ring
	2-substituted-3-hydroxy-naphthoquinones	OH for H, change in alkyl substituents

*See the review by D. W. Woolley in *Physiological Reviews* **27**, 308-333, (1947).

CHEMICAL TESTS FOR DETECTION OF MALNUTRITION[1, 2]

Test	Condition it may detect

Serum Proteins

Total nitrogen by micro- or macro-Kjeldahl analyses.

Specific gravity by falling drop or copper sulfate methods.

Serum albumin and globulin by salting out, followed by Kjeldahl nitrogen analysis.

Hypoproteinemia—occurs when the protein in the diet is severely curtailed for long periods, and/or in a number of diseases, including those involving the liver, kidney, or the loss of protein from the body.

The level of total serum protein is not as significant as that of albumin in evaluating protein nutrition, since the former is influenced by the level of serum globulin, which is increased in a number of pathologic states.

Iron, Hemoglobin and Red Cells

Hemoglobin—photometrically as oxyhemoglobin, acid or alkaline hematin, cyanmethemoglobin or carboxyhemoglobin.

Hemoglobin—indirectly from specific gravity of whole blood, with copper sulfate.

Erythrocyte count—with counting chamber or photoelectrically.

Volume of packed erythrocytes—by hematocrit.

Serum iron—macro- or micro-method.

Anemia—may be produced by deficiency of iron, but also by deficiencies in protein, folic acid, or other less well-defined nutrients.

Iron deficiency anemia is hypochromic and often microcytic, with small erythrocytes low in hemoglobin.

For further characteristics of nutritional anemias see p. 49.

Vitamin A in Blood

Colorimetric analysis based on reaction with antimony trichloride to form blue color.

Ultraviolet spectrophotometry.

Carotene by solvent partition and/or chromatography.

Although there is a relationship between the amount of vitamin A and carotene in the blood and clinical evidence of A deficiency, wide individual variations occur.

A low level of vitamin A in the blood may mean vitamin A deficiency, decreased reserve stores, or the presence of a disease affecting vitamin A metabolism.

1. Based on Section III, by GRACE GOLDSMITH, "Chemical Tests and Their Interpretations," in *National Research Council Bulletin No. 117*, "Nutrition Surveys: Their Techniques and Value" (May, 1949).
2. See "Vitamin Assay Methods," p. 27, for further information on analytical methods for vitamins.

Test	Condition it may detect
Thiamine	
In urine, by yeast fermentation, colorimetric test with *p*-aminoacetophenone, fluorometrically as thiochrome, or as the excretory product, pyramin.	Urinary excretion of thiamine is linearly related to intake, and falls when it is lowered. At low levels of thiamine intake, pyramin can still be determined, although thiamine has fallen to zero.
Determined on either a one-hour fasting sample, or after oral or parenteral test doses.	Fasting one-hour specimens correlate well with the average daily intake, but cannot detect the degree of thiamine deficiency. Load tests—in persons on controlled intakes, the excretion following administration of a test dose diminishes as the thiamine intake is reduced.
In blood as thiamine, cocarboxylase, or by measurement of pyruvic acid, and the lactate-pyruvate ratio during fasting, after glucose and following exercise.	Determination of blood pyruvate after standardized stresses may indicate impaired carbohydrate metabolism from thiamine deficiency or other causes.
Riboflavin	
By microbiological or fluorometric assay in blood or urine. Urinary excretion measured either for one hour during fasting or for several hours after test dose.	The amount of riboflavin excreted in the urine parallels the dietary intake until high levels are reached, at which time the absolute amount excreted is increased, but the percentage little affected.
Nicotinic Acid	
In urine as nicotinic acid and nicotinamide, either microbiologically or colorimetrically by reaction with cyanogen bromide and an amine. In urine as N′-methylnicotinamide. In erythrocytes as pyridine nucleotides, either microbiologically or fluorometrically.	Chemical tests for the appraisal of niacin nutrition have been numerous but far from satisfactory. Wide variations in results have been found. These may be caused by individual differences in the proportion of metabolites excreted, in the methylating ability of the patient, and in the relationship between tryptophane and niacin metabolism. The determination of N′-methylnicotinamide in the urine during fasting and after administration of a test dose of niacinamide is useful in the assessment of nutritional status if interpreted conservatively.

Test	Condition it may detect
Ascorbic Acid	
Measured by reaction with an oxidizing reagent, usually 2,6-dichlorophenolindophenol. Dehydroascorbic acid by reaction with 2,4-dinitrophenylhydrazine.	Low concentrations of plasma ascorbic acid have been interpreted as indicating a deficiency of this vitamin.
Estimates of ascorbic acid concentration may be made on plasma, whole blood, white cell and platelet layer, and estimating urinary excretion during fasting or in a 24-hour period.	Plasma levels mirror the dietary intake, while white cell levels seem to parallel the tissue store.
In load tests, changes in blood or urinary ascorbic acid are measured for varying periods after a test dose.	The results of urinary excretion and load tests should be conservatively interpreted.
Vitamin D and Calcium	
There are no chemical methods which permit estimation of vitamin D in biological materials of low potency.	
Serum alkaline phosphatase.	Serum alkaline phosphatase is elevated early in rickets and parallels the activity of the disease and the healing process. These changes are most marked in infants and young children.
Serum calcium.	Calcium deficiency sufficient to produce changes in the blood levels is rare in the United States and Europe. If serum calcium falls to low levels tetany or osteomalacia may occur.
Vitamin K	
Blood prothrombin level. Clotting time.	A deficiency in vitamin K may be shown by an impairment of blood clotting.
Physical Examination	
"Medical literature abounds with real or supposed physical manifestations of specific nutritional deficiency states. Abnormalities of skin, mucous membranes, hair, nails and neurologic signs are frequently attributed to various deficiencies. Although these signs may be sufficiently demarcated in the rare case to allow objective evaluation, characteristically the physical signs of deficiency states are nonspecific and multiple. The manifestations of deficiency states complicating disease are far more subtle than is commonly believed."*	

*Mann, G. V., and F. J. Stare: *J. Am. Med. Assoc.* **142**, 409 (1950).

BLOOD AND TISSUE CHANGES IN NUTRITIONAL ANEMIAS[1]

DEFICIENT NUTRIENT		BONE MARROW HYPERPLASIA	HEMOSIDEROSIS			HYPERFERREMIA
			Spleen	Liver	Bone Marrow	
Iron	Microcytic hypochromic	?	0	0	0	0
Pyridoxine	Microcytic hypochromic	+	+	+	+	+
Copper	Microcytic hypochromic	?	+	+	+	?
Tryptophane	Normocytic normochromic	0	0	0	0	0
Folic Acid	Macrocytic hyperchromic	?	?	?	?	?
Nicotinic Acid	Macrocytic or normocytic	?	+	?	?	?
Riboflavin	?*	0	0	0	0	?
Cobalt	?	?	+	+	+	?

1. From Richard H. Follis' "The Pathology of Nutritional Disease" (1948). Courtesy of Charles C. Thomas, Publisher, Springfield, Illinois.

*No uniformity.

SPECIFIC CHANGES IN EPITHELIUM PRODUCED BY DEFICIENCIES OF ESSENTIAL NUTRIENTS IN RATS[1]

TYPE OF DEFICIENCY	GROSS DISTRIBUTION AND APPEARANCE	EPITHELIUM	HAIR FOLLICLES	SEBACEOUS GLANDS	CORIUM
VITAMIN A[2]	Lesions only in atrophic skin	Keratinization	Keratinization	No change	No change
LINOLEIC ACID[3]	Scaling of dorsae of feet, necrosis of tip of tail	Hyperkeratosis	?	?	?
RIBOFLAVIN[4]	Alopecia of head, venter, abdomen	Atrophy	Atrophy	Necrosis	Atrophy
PYRIDOXINE[5]	Symmetric scaling, dermatitis of paws, ears, nose, shin, chest; edema of paws	Hyperkeratosis and acanthosis	Intact until late	Intact until late	Edema, hyperemia and inflammation
PANTOTHENIC ACID[6]	Alopecia of venter, scaling of paws, graying of fur	Hyperkeratosis, acanthosis and vesiculation	Dilatation	Intact until late	No characteristic change
BIOTIN[7]	Generalized, scaly, greasy dermatitis with alopecia	Extreme hyper-keratosis and acanthosis	Dilated and plugged	Intact until late	Intact until late
MAGNESIUM[8]	Erythema of paws and ears	Hyperkeratosis, late	Intact	Intact	Dilated vessels
ZINC[9]	Alopecia of dorsum with scaling	Hyperkeratosis, acanthosis and para-keratosis	Atrophy	Hypertrophied	Hyperemic, late

1. From Richard H. Follis' "The Pathology of Nutritional Disease" (1948). Courtesy of Charles C. Thomas, Publisher, Springfield, Illinois.
2. Sullivan, M., and Evans, V. J.: Nutritional dermatoses in the rat. XI. Vitamin A deficiency superimposed on vitamin B complex deficiency. *Arch. Dermat. and Syph.* **51**, 17 (1945).
3. Williamson, R.: A note on the epidermis of the rat on a fat-free diet. *Biochem. J.* **35**, 1003 (1941).
4. Sullivan, M., and Nicholls, J.: Nutritional dermatoses in the rat. IV. Riboflavin deficiency. *J. Invest. Dermatol.* **4**, 181 (1941).
5. Sullivan, M., and Nicholls, J.: Nutritional dermatoses in the rat. I. Vitamin B_6 deficiency. *J. Invest. Dermatol.* **3**, 317 (1940).
6. Sullivan, M., and Nicholls, J.: Nutritional dermatoses in the rat. VI. The effect of pantothenic acid deficiency. *Arch. Dermat. and Syph.* **45**, 917 (1942).
7. Sullivan, M., and Nicholls, J.: Nutritional dermatoses in the rat. V. Signs and symptoms resulting from a diet containing unheated, dried egg white as the source of protein. *Arch. Dermat. and Syph.* **45**, 295 (1942).
8. Sullivan, M., and Evans, V. J.: Nutritional dermatosis in the rat. IX. Evaluation of the interrelationships of magnesium deficiency and deficiencies of the vitamin B complex. *J. Nutrition* **27**, 123 (1944).
9. Follis, R. H., Jr., Day, H. G., and McCollum, E. V.: Histological studies of the tissues of rats fed a diet extremely low in zinc. *J. Nutrition* **22**, 223 (1941).

UTILIZATION OF FOODSTUFFS

Products of Digestion	Intermediate Products	End Products
Proteins		
Proteoses. Polypeptides. Peptides. Amino acids.	Tissue proteins. Blood sugar and liver glycogen. Tissue fat. Hormones (*i.e.*, thyroxin, epinephrine, etc.). *Alpha*-keto and hydroxy acids. Purines, creatinine.	Carbon dioxide. Urea, ammonium salts, creatine, creatinine, and uric acid. Sulfates and phosphates. Amino acids and proteins. Water.
Carbohydrates		
Glucose (blood sugar). Fructose. Galactose. Dextrins. Maltose. Pentoses.	Hexosephosphates. Triosephosphates. Pyruvic acid. Glycogen. Tissue fats.	Carbon dioxide. Water. Lactic acid.
Fats		
Fatty acids. Glycerol. Emulsions (with bile acids).	Depot fats. Acetoacetic acid. Acetic acid. Phospholipids and cerebrosides.	Carbon dioxide. Water. Acetone bodies. Synthesis of glycogen, fatty acids, cholesterol, protoporphyrin, uric acid and dicarboxylic amino acids.
Minerals		
Soluble salts.	Soluble salts. Organo-metallic compounds. Bone and tooth structures.	Soluble salts, eliminated by kidneys. Insoluble salts by intestines.
Vitamins		
Soluble organic compounds.	Enzymes, etc., in cellular reactions, especially those involved in oxidation.	In part eliminated by kidneys, intestines, and sweat glands. Partial oxidation and elimination as derived products.

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INTERMEDIARY METABOLISM

CARBOHYDRATES

A. **Carbohydrates**[1] $\longrightarrow$ Glucose; Fructose $\xrightarrow[\textit{Fructokinase}]{+\text{ATP}^2}$ Fructose-6-phosphate

$$+\text{ ADP} \underset{}{\overset{\textit{Isomerase}}{\rightleftharpoons}} \text{Glucose-6-phosphate} \overset{\textit{Phosphatase}}{\rightleftharpoons} \text{Glucose} + \text{H}_3\text{PO}_4$$

B. $\text{Glucose} \xrightarrow[\substack{\textit{Hexokinase,}\\ \textit{Mg}^{++}}]{+\text{ATP}} \text{Glucose-6-phosphate} + \text{ADP} \overset{\textit{Phospho-}}{\rightleftharpoons} \underset{\substack{\textit{glucomutase,}\\ \textit{Mg}^{++}\textit{, cysteine}}}{\text{Glucose-1-phosphate}}$

$$\overset{\substack{\textit{Phosphorylase,}\\ \textit{Mg}^{++}\text{, A.A.}}}{\rightleftharpoons} \text{Glycogen} + \text{H}_3\text{PO}_4$$

C. $\text{Glucose-6-phosphate} \overset{(3)}{\rightleftharpoons} \text{Fructose-6-phosphate} \underset{\textit{fructokinase, Mg}^{++}}{\overset{+\text{ATP, }\textit{Phospho-}}{\rightleftharpoons}} \text{Fructose-1,6-diphosphate}$

$$\text{Fructose-1,6-diphosphate} + \text{ADP} \overset{\textit{Aldolase}}{\rightleftharpoons} \text{3-Phosphoglyceraldehyde, Phosphodihydroxy acetone} \rightleftharpoons$$

$$\rightleftharpoons \overset{+\text{H}_3\text{PO}_4}{\rightleftharpoons} \text{1,3-Diphosphoglyceraldehyde} \overset{+\text{DPN}}{\rightleftharpoons} \text{1,3-Diphosphoglyceric acid}$$

$$\text{1,3-Diphosphoglyceric acid} + \text{DPN}\cdot\text{H}_2 \overset{+\text{ADP}}{\rightleftharpoons} \text{3-Phosphoglyceric acid} + \text{ATP} \overset{\textit{Triose mutase}}{\rightleftharpoons}$$

$$\rightleftharpoons \text{2-Phosphoglyceric acid} \underset{\substack{+\text{H}_2\text{O}\\ \textit{Mg}^{++}}}{\overset{\textit{Enolase}}{\overset{-\text{H}_2\text{O}}{\rightleftharpoons}}} \text{Phospho-enol-pyruvic acid} \overset{+\text{ADP}}{\rightleftharpoons} \text{Pyruvic acid} + \text{ATP}$$

C′. (*Summarized*) $\underset{\text{Hexose (glucose or fructose)}}{\text{C}_6\text{H}_{12}\text{O}_6} + \text{ATP} + 2(\text{DPN}) \longrightarrow \underset{\text{Pyruvic acid}}{2\text{CH}_3\cdot\text{CO}\cdot\text{COOH}} + 2(\text{ATP}) + 2(\text{DPN}\cdot\text{H}_2)$

D. (*Aerobically*) $2(\text{DPN}\cdot\text{H}_2) + \text{Flavin} + \text{Cytochrome, etc.} + \text{O}_2 \longrightarrow 2(\text{DPN}) + 2\text{H}_2\text{O}$

(*Anaerobically*[4]) $\underset{\text{Pyruvic acid}}{2(\text{DPN}\cdot\text{H}_2) + 2\text{CH}_3\cdot\text{CO}\cdot\text{COOH}} \longrightarrow 2(\text{DPN}) + \underset{\text{Lactic acid}}{2\text{CH}_3\cdot\text{CHOH}\cdot\text{COOH}}$

E. (*Aerobically*[5, 6]) $CH_3 \cdot CO \cdot COOH + CO \cdot COOH \xrightarrow{-H_2O} HOOC \cdot C = CH \cdot COOH \xrightarrow[-CO_2, -2H]{+H_2O}$

$CH_2 \cdot COOH \qquad\qquad CH_2 \cdot CO \cdot COOH$

Pyruvic acid[7] Oxaloacetic acid Pyruvofumaric acid[8]

$HOOC \cdot C = CH \cdot COOH \xrightarrow{+H_2O} HOOC \cdot CH \cdot CHOH \cdot COOH + TPN \rightleftharpoons$

$CH_2COOH \qquad\qquad CH_2COOH$

cis-Aconitic acid Isocitric acid

$\xrightarrow{-2H} HOOC \cdot CH \cdot CO \cdot COOH \xrightarrow{-CO_2}$

$CH_2 \cdot COOH + TPN.H_2$

Oxalosuccinic acid

$\rightleftharpoons CH_2 \cdot CO \cdot COOH \xrightarrow[-2H-CO_2]{+H_2O} CH_2 \cdot COOH \underset{+2H}{\overset{-2H}{\rightleftharpoons}} CH \cdot COOH \xrightarrow[-H_2O]{+H_2O}$

$CH_2 \cdot COOH \qquad\qquad CH_2 \cdot COOH \qquad\qquad CH \cdot COOH$

α-Ketoglutaric acid Succinic acid Fumaric acid

$\rightleftharpoons CHOH \cdot COOH \underset{+2H}{\overset{-2H}{\rightleftharpoons}} CO \cdot COOH$

$CH_2 \cdot COOH \qquad\qquad CH_2 \cdot COOH$

Malic acid Oxaloacetic acid

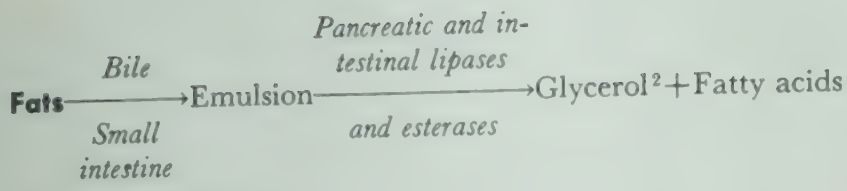
E′ (*Summarized*) $CH_3 \cdot CO \cdot COOH + 2\frac{1}{2}O_2 \longrightarrow 3CO_2 + 2H_2O$

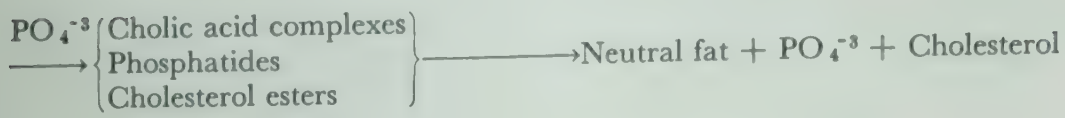
Pyruvic acid

---

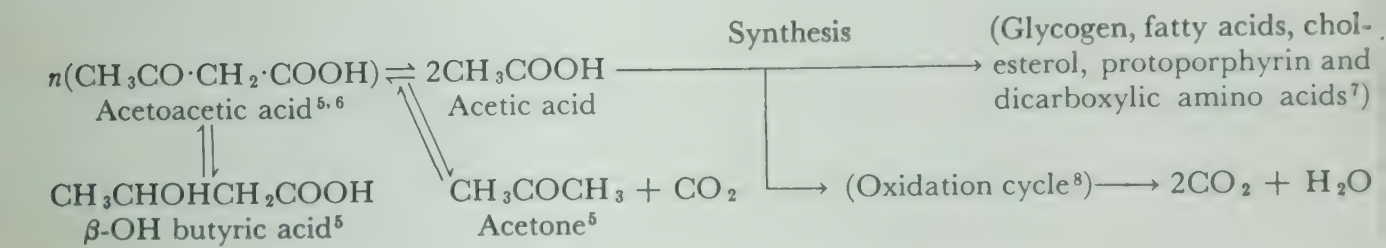
1. For review articles see: Soskin, S., and Levine, R., "Carbohydrate Metabolism," University of Chicago Press, (1946), and Peters, J. P., and Van Slyke, D., "Quantitative Clinical Chemistry" (2nd Ed.) Vol.I, p. 97-273. Williams and Wilkins, Baltimore (1946).
2. *Glossary.* ATP—adenosine triphosphate (adenine-9-*d*-ribofuranoside-5′-triphosphate). ADP—adenosine diphosphate. AA—adenylic acid. DPN—diphosphopyridine nucleotide (Coenzyme I). DPN.H_2—reduced diphosphopyridinenucleotide (reduced Coenzyme I). TPN—triphosphopyridine nucleotide.
3. See equations (A) and (B) for the formation of glucose-6-phosphate.
4. In oxygen deficiency, as in muscle during exercise, lactic acid is the chief product of carbohydrate metabolism.
5. In the presence of oxygen, pyruvic acid is completely oxidized.
6. Tricarboxylic acid cycle, proposed by H. A. Krebs. See "Advances in Enzymology" **3**, 191. Interscience Publishers, New York (1943).
7. Pyruvic acid is probably oxidatively decarboxylated to "active acetic acid" or 2-carbon fragments before condensation with oxaloacetic acid.
8. One of several intermediate compounds proposed for this stage.

FATS[1]





In the liver



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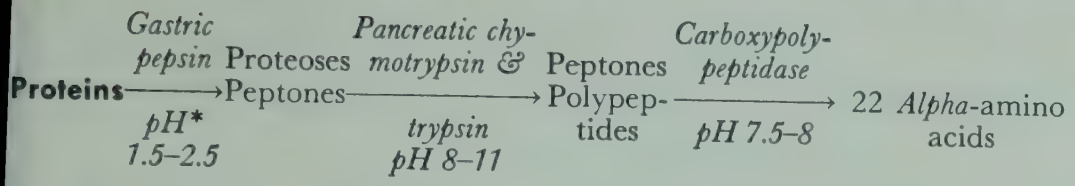
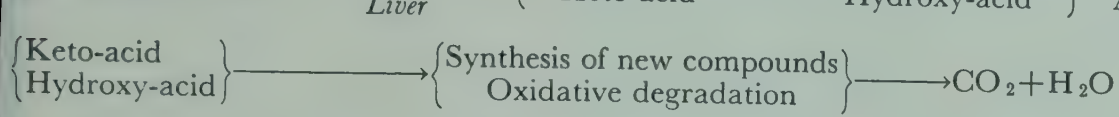
1. See review articles by:
   BLOOR, W. R., "Biochemistry of the Fatty Acids," Reinhold Pub. Corp., New York (1943).
   SMITH, J. A. B.: *J. Soc. Chem. Ind.* **17**, 213 (1939).
   STADIE, W. C.: *Physiol. Rev.* **25**, 395 (1945).
   WOOD, H. G.: *Physiol. Rev.* **26**, 198 (1946).
2. Converted to glycogen, and burned as carbohydrate.
3. Proposed by HURTLEY, W. H., *Quart. J. Med.* **9**, 301 (1916).
4. Other possible pathways are the classical successive beta-oxidation of KNOOP, F., [*Beitr. Z. Chem. Phys. u. Path.* **6**, 150 (1904)], and successive beta-oxidation with condensation of the 2 carbon fragments to form 4 carbon units, proposed by MACKAY, E. M.: [*J. Clin. Endocrinol.* **3**, 101 (1943)]. The latter hypothesis has the same physiological significance as multiple alternate oxidation. A secondary pathway is the omega-oxidation of VERKADE, P. E., [*Chem. & Ind.* **57**, 704 (1938)], with the production of dicarboxylic acids.
5. These 3 compounds are the "acetone bodies" of diabetic ketosis, a condition in which the liver produces acetoacetic and beta-hydroxy butyric acids more rapidly than they can be burned by the tissues.
6. It is probable that the end product of β-oxidation is neither acetoacetic nor acetic acids, but an, as yet unidentified, 2-carbon fragment, which resembles acetyl phosphate. These fragments may either undergo oxidation or condense to form acetoacetic acid.
7. See review article by BLOCH, K.: [*Physiol. Rev.* **27**, 574 (1947)].
8. Our knowledge of the metabolic pathways involved in the oxidation of acetic acid, or its hypothetical 2-carbon precursor, is as yet not sufficiently detailed to permit listing of specific compounds involved in this cycle. The intermediate stages probably involve phosphorylated intermediates. There is a growing body of evidence pointing to the tricarboxylic acid cycle (see equation E on p. 53) as the mechanism through which acetate undergoes biological oxidation.

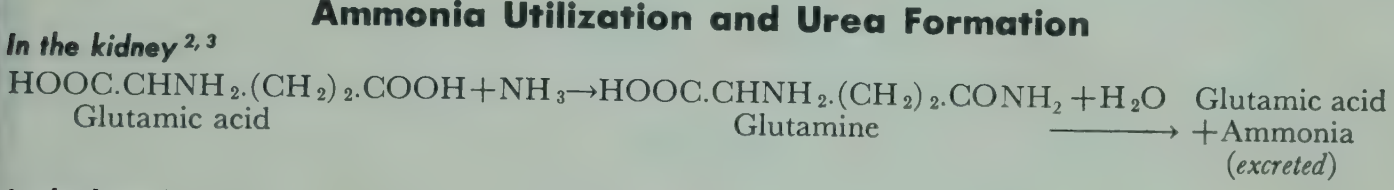
NITROGEN COMPOUNDS



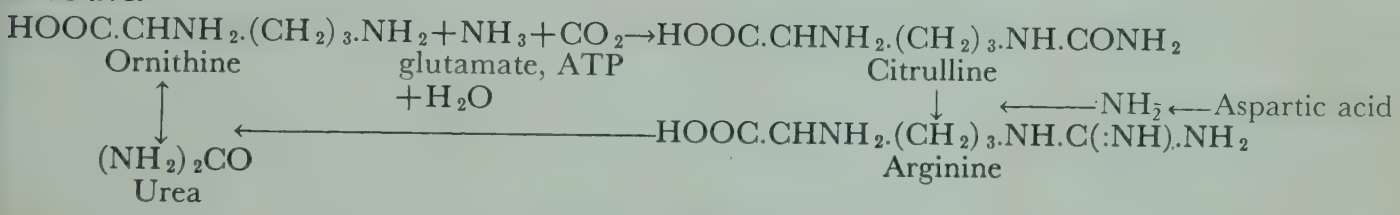


Ammonia Utilization and Urea Formation

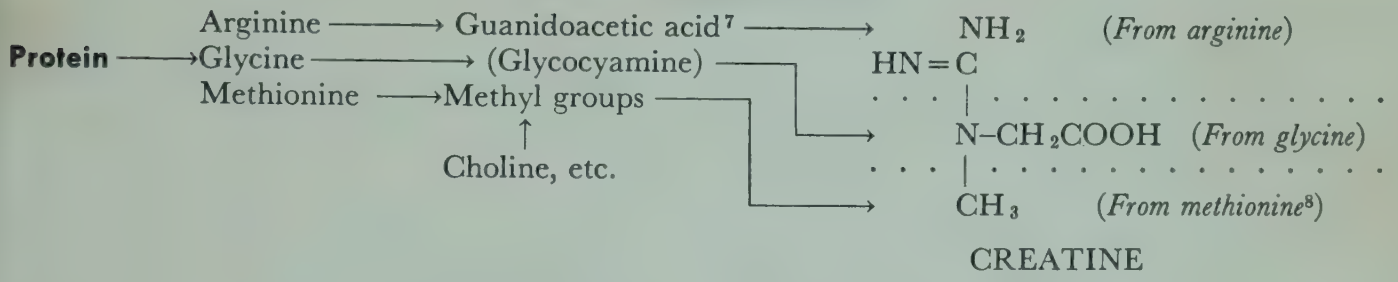
In the kidney [2, 3]

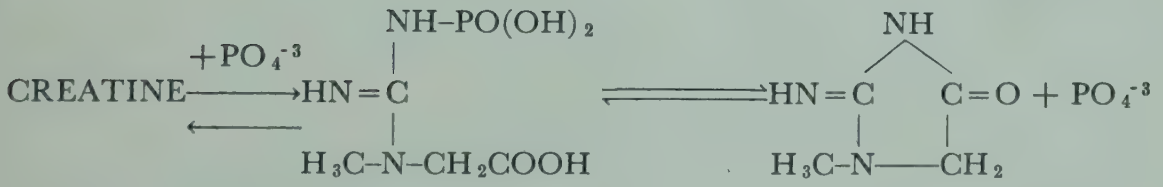


In the liver [4, 5]



Creatine Metabolism[6]





*Optimal pH for enzyme action.

1. Type formula for all α-amino acids, except proline and hydroxyproline, in which the characteristic group is –HN–CH–COOH, and R is part of a pyrrolidine ring, instead of an aliphatic chain. In glycine, R represents an H atom.
2. Van Slyke, D. D., *et al.*: *J. Biol. Chem.* **150**, 481 (1943).
3. It is probable that the formation of glutamine is a mechanism for the storage of ammonia in non-toxic form.
4. Krebs, H. A., and Henseleit, H.: *Z. Physiol. Chem.* **210**, 33 (1932).
5. See the review by Lipmann, F, and Kaplan, N. O.: *Ann. Rev. Biochem.* **18**, 273 (1949).
6. Peters, J. P., and Van Slyke, D. D.: "Quantitative Clinical Chemistry," Vol. 1 (2nd ed.), p. 914, Williams and Wilkins, Baltimore (1947).
7. Borsook, H., and Dubnoff, J.: *J. Biol. Chem.* **138**, 389 (1941).
8. Vigneaud, V. Du., Cohn, M. *et al.*: *J. Biol. Chem.* **140**, 625 (1941).

ENZYMES INVOLVED IN DIGESTION*

Enzyme	Action	Where Found
	On Carbohydrates	
Ptyalin (salivary diastase)	Converts starch to maltose	Salivary secretion
Amylase (pancreatic diastase)	Converts starch to maltose	Pancreatic secretion
Phosphorylase	Converts glycogen to glucose	Liver, muscles
Sucrase	Converts cane-sugar to glucose and levulose	Small intestine
Maltase	Converts maltose to glucose	Small intestine, salivary and pancreatic secretion
Lactase	Converts lactose to glucose and galactose	Small intestine
	On Fats	
Lipase (steapsin)	Splits neutral fats to fatty acids and glycerol	Pancreatic secretion, fat, tissues, blood, etc.
	On Proteins	
Pepsin	Converts proteins to peptones and proteoses	Gastric juice
Trypsin	Splits proteins into small polypeptid groupings	Pancreatic juice
Dipeptidase	Splits dipeptids into their constituent amino-acids; is a principal constituent of "erepsin"	Small intestine
Aminopolypeptidase	Acts on polypeptids containing a free amino group; probably a group of enzymes	Small intestine
Carboxypeptidase	Acts on polypeptids containing a free carboxyl group	Pancreas
Autolytic enzymes	Split proteins, carbohydrates and fats into smaller molecules	Tissues generally
	Deaminizing Enzymes	
Guanase	Converts guanine to xanthine by splitting off an NH_2 group as ammonia (NH_3)	Thymus, adrenals, pancreas
Adenase	Converts adenine to hypoxanthine by splitting off an NH_2 group as ammonia (NH_3)	Spleen, pancreas, liver
Deaminase	Splits off the NH_2 group from the amino-acids with the formation of non-nitrogenous organic acids	Tissues generally

*Reproduced by permission from FULTON, JOHN F., *et al.*: "Howell's Textbook of Physiology" (15th ed.), W. B. Saunders Company, Philadelphia (1946); pp. 1025-1026.

THE ALKALINE OR ACID EFFECT OF FOODS

SULFUR, phosphorus and chlorine are the chief acid-forming elements in foods; sodium, potassium, calcium and magnesium the important base-formers. By analysing a food for these elements, calculating the results in terms of "normal acid" and "normal alkali" solutions, and comparing the total "acid" value with that for total "alkali" one can determine whether this food is predominantly acid or alkaline in its effect in the body.

Foods rich in protein contain sulfur, which is oxidized in the body to yield sulfate, and usually phosphorus which is burned to phosphate. Both of these acids are "strong" acids, capable of significantly increasing the true acidity of the urine. This acid is neutralized in part by the alkaline elements and in part by ammonia, which the kidney can make when needed for neutralization. Therefore, protein-rich foods are "acidic" in their effect on the body.

In most fruits and vegetables the alkaline elements exceed the acid ones. Therefore, these are alkaline in their effect. It might be supposed that the presence in many foods of organic acids and related compounds (*e.g.*, citric acid in citrus fruits, tartaric acid in grapes and malic acid in apples) would give them an acid reaction in the body. Such is not the case. These organic acids are oxidized to form carbon dioxide, eliminated in part as CO_2 via the lungs and in part as sodium carbonate and/or bicarbonate by the kidneys. Since carbonic acid is a weak acid, its salts with strong bases give alkaline solutions.

A few fruits, such as cranberries, plums and prunes, are exceptions to this rule. They contain substantial amounts of such organic acids as benzoic and quinic acids, which the body cannot oxidize to carbonic acid, and which, therefore, are eliminated through the kidney in acid forms.

It should be evident that one cannot predict that a food will have an acid effect in the body just because it tastes sour.

Certain leafy foods (*e.g.*, rhubarb, chard, spinach and beet tops) contain oxalic acid, which is poorly oxidized. Morever, this acid will react with calcium ions to form the highly insoluble compound, calcium oxalate. When this occurs, the calcium thus bound is rendered unavailable to the body. When such foods are eaten, a liberal supply of calcium from other sources, such as milk, eggs and beans, should be eaten to offset this "loss" of calcium.

A normal, healthy body is well equipped to utilize efficiently the food eaten regardless of its alkaline or acid properties. The bicarbonates, phosphates and proteins always found in the blood act as buffers to protect the tissues and blood against sudden changes in their normal, slightly alkaline reaction. Those overly concerned with an "acid stomach" should be reminded that the normal pH of the gastric juice is between 0.8 and 0.9 of a pH unit, corresponding to about 0.17 N hydrochloric acid. It is fortunate that the body has the ability to resist most efforts of the uninformed to tamper with the pH of its fluids.

DIETARY TOXICOLOGY

FOOD-POISONING is a blanket term, which may cover a multitude of diagnostic errors. Although certain "foods" may be intrinsically poisonous, in general, foods producing toxic reactions do so as carriers of pathogens, toxins from spoilage organisms, or heavy metals.

Bacterial Contamination

Staphylococci, streptococci and salmonella organisms may be found in improperly prepared foods. All of these may produce symptoms of nausea, vomiting, severe colic, diarrhea and prostration. Staphylococci grow rapidly in some foods, such as milk, cured meats, cream-filled bakery goods, etc., and elaborate an enterotoxin within a few hours at suitable temperatures. Salmonella food poisoning is actually an infection, caused by the ingestion of living salmonella organisms. *Alpha*-type streptococci, when eaten in enormous numbers, may also produce symptoms of food poisoning in man, although culture filtrates of these organisms do not. These attacks, although uncomfortable, are rarely fatal; they may be prevented by adequate sanitation and heat treatment in the preparation of the food.

Many attacks of food poisoning have, in the past, falsely been ascribed to "ptomaine poisoning." Ptomaines are alkaloids formed during the putrefaction of protein. They may be lethal if injected, but not if ingested. Furthermore, a protein which has decayed enough to produce them is too repulsive to be eaten. Ptomaine poisoning, as such, is now an historical curiosity, rather than a practical problem.

Botulism

Clostridium botulinum is widely distributed in soils and may contaminate certain raw foods. Its toxin is one of the most poisonous non-radioactive substances known. The clinical manifestations of botulism include: headache, nausea, involvement of vision, often proceeding to blindness, difficulty in swallowing, and talking, ascending paralysis, and death. Mortality is about 75 per cent of those affected. Death occurs in from 48 hours to 10 days after onset. The specific antitoxins "A," "B" or "E" are used in therapy; large doses of polyvalent antitoxin are given when the specific type is unknown.

The toxin is heat labile, the most resistant form requiring a thirty-minute exposure at 89° C. (176° F.) for complete inactivation. A suspected food brought to a boil and simmered for five minutes could be eaten with impunity. Scientific control of sterilization, as practiced by progressive food manufacturers, has eliminated botulism from commercially packed foods. Since 1925 all cases of botulism have been traced to home canned foods. Substitution of the pressure cooker for the water-bath method in home canning should go far to eliminate botulism in home packed foods.

Heavy Metals

Several harmful metals may occur in food products. These include: lead, arsenic, antimony, cadmium, copper, and zinc. Excessive amounts of any of these may produce poisoning, though trace amounts of some are beneficial. Lead, arsenic, and cadmium are perhaps the most dangerous. Iron, tin, and aluminum containers do not cause food poisoning. Foods or beverages should not be left in contact with zinc, copper, lead-lined, or cadmium-plated utensils, as they may dissolve appreciable amounts of these metals. Cumulative poisoning may result from the use of foods or water from regions rich in fluorides or selenium.

Poisonous "Foods"

Certain plants and fungi when consumed, are poisonous. Poisoning is usually accidental, and frequently occurs among children, who are especially liable to eat the attractive leaves or berries. These plants contain various alkaloids; *e.g.*, hemlock (coniine), monkshood (aconitine), deadly night-shade (atropine), foxglove (digitalis), and rhubarb leaves (oxalic acid). Favism may be caused by eating the fava bean, or being near the plants when they are in blossom. The symptoms include acute febrile anemia with jaundice, hematuria and hemoglobinuria. Snakeroot poisoning, characterized by weakness, prostration and vomiting, may be caused by drinking milk from cows pastured in areas where snakeroot is abundant. Ergotism, rare in this country, comes from eating rye or bread contaminated with the fungus, *Claviceps purpurea*.

Mushrooms

Mushroom poisoning (mycetismus) in the United States is largely caused by the *Amanita* genus; the delicious but deadly *phalloides* species causes nearly 90 per cent of the fatalities. Poisonous mushrooms can be distinguished from edible ones only by their botanical characteristics—not by such dangerous lay tests as the tarnishing of a silver coin. Two types of mushroom poisoning occur in this country, the *rapid* and the *delayed*.

The rapid type is caused by *Amanita muscaria*, which contains the alkaloid, muscarine. Symptoms usually occur within an hour and resemble those of pilocarpine poisoning; atropine is a specific antidote. In fatal cases death occurs within a few hours.

The delayed form of poisoning results from *Amanita phalloides*, which contains several unidentified toxins. Symptoms appear from 6 to 15 hours after ingestion. They include marked gastrointestinal disturbances, dehydration, degenerative changes of liver and kidneys resulting in jaundice and anuria, extensive capillary damage, toxic action on cardiac muscle and the central nervous system. Mortality rate is over 50 per cent; therapy is symptomatic and supportive. Mushroom picking cannot be recommended as a dilettante hobby.

Sea food

Many kinds of fish, especially those found in tropical waters, may produce symptoms of poisoning. Most common in this country is mussel poisoning on the Pacific Coast. At certain times of the year the mussels feed on a unicellular marine microorganism, which contains a toxic alkaloid. Typical symptoms include nausea, vomiting, incoordination, and mydriasis; death results from respiratory paralysis.

General

The bacteria producing food poisoning are inhibited in acid media and because of this fruits and vegetables of low pH need somewhat less heat treatment than foods of higher pH. However, scrupulous care is necessary in handling all types of foods, whatever their acidity, because high contamination of even acid foods might result in spoilage.

Canned foods may be left in their original containers after opening, since the can has been sterilized, while the ordinary dishes into which a housewife transfers the contents are far from sterile. It may be desirable to transfer acid fruits from the tin to glass containers to prevent the development of off-flavors which might be misconstrued as being harmful.

The intestinal infections that are severe and of long duration such as typhoid, cholera, and amebic dysentery may be spread by unsanitary practices in distributing either food or water.

FOOD ALLERGY*

"FOOD ALLERGIES are more common in infants and young children than in later life. This predilection is probably explained by the greater permeability of the intestinal tract of these subjects to unaltered protein. The most commonly implicated protein foods are milk, egg, wheat, meat and fish. In order of increasing age, clinical hypersensitivity is manifested by infantile eczema, angioneurotic edema, mucous colitis and bronchial asthma. Detection of the responsible protein or proteins is made preferably by therapeutic test (ingestion) or by skin tests, the latter yielding reliable results in roughly one-half of the cases. If possible, avoidance of the specific foodstuff with the substitution of other protein foods is the therapeutic method of choice. If sensitivity to multiple proteins is present, elimination diets may be so low in this foodstuff as to lead to body protein depletion. This eventuality may be obviated by attempts at immunization (desensitization) which are often unsatisfactory or preferably by resort to protein hydrolysates which have lost their biologic specificity. When amino acid mixtures become more freely available, they will undoubtedly serve an increasingly important therapeutic role in food allergies."

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*Reproduced from "Proteins and Amino Acids in Nutrition," MELVILLE SAHYUN, Ed., Reinhold Publishing Corp. (1948), Chapter 13 by S. Z. LEVINE, p. 336, by permission of the publisher.

FOOD FACTS

SUGARS and starches *per se*, are not harmful, but their excessive use lessens the desire for foods rich in vitamins and minerals. Such excessive use may produce obesity, many ailments associated with excess body weight, and possibly higher incidence of dental caries. Practically all natural foods contain sugars and starches mixed with proteins. When eaten together they supplement each other.

Shell fish and other marine products which are wholesome when eaten alone, do not become poisonous by admixture with other foods such as milk or ice cream. Poisoning or injury from "food combinations" is unknown.

A person of sedentary habits requires almost as much protein as a person at hard labor; however, less carbohydrate and fat are needed.

Canned foods packed under scientific control by modern food manufacturers are wholesome, sanitary, thoroughly cooked and easily digestible. They retain their vitamin and mineral content to a high degree.

Most of the "acid" (sour) fruits and vegetables give an alkaline reaction in the body, and hence are likely to be beneficial in an "acid system," rather than injurious. (See p. 57.)

The addition of table salt improves the flavor and nutritive value of foods. Sodium restriction is only necessary in certain special diets.

Moderation should be exercised in the use of raw vegetables. Excessive amounts may prove irritating. In general, vegetables, eggs and meats are more nutritious when cooked.

Cellulose is an important food constituent because of its bulk-imparting properties; excessive amounts of coarse roughage may cause irritation to the gastrointestinal tract.

"Instinct" cannot be relied upon in food selection, particularly with children. A reasonable amount of discipline and intelligence should be exercised in the selection of a good diet.

Many people believe that nuts possess unique nutritional value and that they are complete in all essential nutrients. This view is not supported by experimental studies on the nutritive properties of nuts. They provide certain essential nutrients, such as vitamins of the B-complex but are not complete in all essentials needed in the human diet. Nut proteins are not of high biological value.

Frozen foods are wholesome, sanitary and retain their vitamin and mineral content to a high degree.

Many foods such as lettuce, eggs, meat and fish possess desirable nutritive properties as sources of vitamins, minerals and proteins. There is no scientific evidence to support the belief that certain foods possess specific medicinal or psychological qualities.

HUMAN NUTRITIVE REQUIREMENTS

THERE ARE in this country at the present time two sets of dietary allowances, those of the Food and Drug Administration, Federal Security Agency, and those of the Food and Nutrition Board, National Research Council.

Minimum Daily Requirements, Food and Drug Administration

Section 403 of the Federal Food, Drug and Cosmetic Act states that: "(*A food shall be deemed to be misbranded*—) [*j*] *If it purports to be or is represented for special dietary uses, unless its label bears such information concerning its vitamin, mineral, and other dietary properties as the Administrator determines to be, and by regulations prescribes as, necessary in order fully to inform purchasers as to its value for such uses. Regulation (1.11)* [*a*] *The term 'special dietary uses', as applied to food for man, means particular (as distinguished from general) uses of food, as follows:*

"*Uses for supplying particular dietary needs which exist by reason of a physical, physiological, pathological or other condition, including but not limited to the conditions of disease, convalescence, pregnancy, lactation, allergic sensitivity to food, underweight, and overweight;*

"*Uses for supplying particular dietary needs which exist by reason of age, including but not limited to the ages of infancy and childhood;*

"*Uses for supplementing or fortifying the ordinary or usual diet with any vitamin, mineral, or other dietary property. Any such particular use of a food is a special dietary use, regardless of whether such food also purports to be, or is represented for general use.*"

It was necessary for the Administrator to determine and prescribe the minimum daily requirements of specific nutrients. For legal reasons, the levels chosen were such that amounts less than these would produce demonstrable deficiency signs. We give below the regulations under section 403 [j], as published in the *Federal Register*, Nov. 22, 1941.

MINIMUM DAILY REQUIREMENTS OF SPECIFIC NUTRIENTS

U. S. Food and Drug Administration

	INFANTS	CHILDREN 1–5 YRS. INCLUSIVE	CHILDREN 6–11 YRS. INCLUSIVE	CHILDREN 12 YRS. AND OVER	ADULTS	PREGNANCY OR LACTATION
A—*U.S.P. units* . . .	1500	3000	3000	4000	4000	. . . .
B_1—*mg*.	.25	.50	.75	1.00	1.00	. . . .
C—*mg*.	10	20	20	30	30	. . . .
D*—*U.S.P. units* . .	400	400	400	400	400	. . . .
G(B_2)—*mg*.	0.5	. . . .	. . . .	2.0	2.0	. . . .
Calcium—*g*.	. . . .	.75	.75	.75	.75	1.50
Phosphorus—*g*	. . . .	.75	.75	.75	.75	1.50
Iron—*mg*.	. . . .	7.5	10.0	10.0	10.0	15.0
Iodine—*mg*.	. . . .	0.1	0.1	0.1	0.1	0.1

*Cow's milk containing 135 units of vitamin D per quart, and evaporated milk containing 7.5 U.S.P. units per avoirdupois ounce, usually will prevent clinical rickets when fed to normal infants in customary quantities.

Recommended Dietary Allowances, Food and Nutrition Board, National Research Council

These dietary standards are intended to be sufficiently liberal to "be suitable for maintenance of good nutritional status."

As stated in "Recommended Dietary Allowances, Revised 1948" (N. R. C. Reprint and Circular Series No. 129, Oct. (1948):

"The quantitative data in the accompanying table are intended to represent exactly what is implied in a literal interpretation of the words *recommended dietary allowances*. Hence, in contrast to some previously promulgated standards, the data in the following table are rather to be understood as representing levels of nutrient intakes which the Food and Nutrition Board recommends as normally desirable goals or objectives.

"The recommendations are not called 'requirements' because they are intended to represent not merely the literal (minimal) requirements of average individuals, but levels enough higher to cover substantially all individual variations in the requirements of normal people.

"The figures here recommended are, therefore, generally higher than average requirements but generally lower than the doses used to meet needs created by pathological states or certain environmental conditions or in compensating for an earlier period of depletion . . .

"Studies on man, as well as more complete experience with animals, clearly indicate substantial improvements in growth and function when the intakes of certain nutrients are increased above the level which is just sufficient to prevent obvious deficiency symptoms. The level above which lesions or symptoms are not commonly observed is merely one point on a long curve relating intake to function. The allowance of a margin of intake above the critical level for each nutrient is, therefore, designed to permit additional benefits as well as to cover individual variations. No fixed formula for computing the margin between 'minimal requirements' and 'recommended allowances' would be equally logical for all nutrients or all population groups. There is now much evidence from long-term animal experimentation that, aside from individual variations of need, the margins between optimal intake and minimal requirements are wider for some nutrients than for others. In the judgment of the Board substantially lower levels than those given in the accompanying table would not be expected to give equally good results with large numbers of people through long periods of time . . .

"As indicated previously, the nutrient factors differ in respect to desirability of surplus intake. The usual undiscriminating view is that, if the diet furnishes enough of any given factor to meet functional need, any further amount supplied by the food is normally a matter very nearly of indifference, significant only as a sort of insurance against some emergency. This may be true for most of the essential food factors. Of a few nutrients, however, there is evidence from long-term (animal) experimentation that one may, in the course of a lifetime, derive increased benefit from increased intake up to levels very considerably above those of normally accepted adequacy. (Ascorbic acid, vitamin A, and calcium are perhaps the best established cases of this kind). Conversely, it may be true of some other nutrient factors that surplus intakes should be held within bounds if undesirable consequences are to be avoided. The outstanding and undisputed example of the latter is the energy value of calories of the diet, of which any considerable surplus tends to induce overweight."

We give on the next page the Recommended Dietary Allowances of the Food and Nutrition Board. Those interested in further details are referred to the original publication.

RECOMMENDED DAILY

Revised

Food and Nutrition Board

	CALORIES[2]	PROTEIN grams	CALCIUM grams
Man (154 lb., 70 kg.)			
Sedentary	2400	70	1.0
Physically Active	3000	70	1.0
With Heavy Work	4500	70	1.0
Woman (123 lb., 56 kg.)			
Sedentary	2000	60	1.0
Moderately Active	2400	60	1.0
Very Active	3000	60	1.0
Pregnancy (latter half)	2400[7]	85	1.5
Lactation	3000	100	2.0
Children up to 12 yrs.[8]			
Under 1 yr.[9]	110/2.2 lb. (1 kg.)	3.5/2.2 lb. (1 kg.)	1.0
1-3 yrs. (27 lb. 12 kg.)	1200	40	1.0
4-6 yrs. (42 lb., 19 kg.)	1600	50	1.0
7-9 yrs. (58 lb., 26 kg.)	2000	60	1.0
10-12 yrs. (78 lb., 35 kg.)	2500	70	1.2
Children over 12 yrs.[8]			
Girls, 13-15 yrs. (108 lb., 49 kg.)	2600	80	1.3
16-20 yrs. (122 lb., 55 kg.)	2400	75	1.0
Boys, 13-15 yrs. (108 lbs., 49 kg.)	3200	85	1.4
16-20 yrs. (141 lb., 64 kg.)	3800	100	1.4

1. Objectives toward which to aim in planning practical dietaries: The recommended allowances can be attained with a good variety of common foods which will also provide other minerals and vitamins for which requirements are less well known.
2. Calorie allowances must be adjusted up or down to meet specific needs. The calorie values in the table are therefore not applicable to all individuals but rather represent group averages. The proper calorie allowance is that which over an extended period will maintain body weight or rate of growth at the level most conducive to well-being.
3. The allowance depends on the relative amounts of vitamin A and carotene. The allowances of the table are based on the premise that approximately two-thirds of the vitamin A value of the average diet in this country is contributed by carotene and that carotene has half or less than half the value of vitamin A.
4. For adults (except pregnant and lactating women) receiving diets supplying 2000 calories or less, such as reducing diets, the allowances of thiamine, and niacin may be 1 mg. and 10 mg. respectively. The fact that figures are given for different calorie levels for thiamine and niacin does not imply that we can estimate the requirement of these factors within 500 calories, but they are added merely for simplicity of calculation. In the present revision, riboflavin allowances are based on body weight rather than caloric levels. Other members of the B-complex also are required, though no values can be given. Foods supplying adequate thiamine, riboflavin, and niacin will tend to supply sufficient of the remaining B vitamins.

DIETARY ALLOWANCES[1]

948

National Research Council

IRON mg.	VITAMIN A[3] I.U.	THIAMINE[4] mg.	RIBOFLAVIN[4] mg.	NIACIN (NICOTINIC ACID)[4] mg.	ASCORBIC ACID mg.	VITAMIN D I.U.
12[5]	5000	1.2	1.8	12	75	[6]
12[5]	5000	1.5	1.8	15	75	[6]
12[5]	5000	1.8	1.8	18	75	[6]
12	5000	1.0	1.5	10	70	[6]
12	5000	1.2	1.5	12	70	[6]
12	5000	1.5	1.5	15	70	[6]
15	6000	1.5	2.5	15	100	400
15	8000	1.5	3.0	15	150	400
6	1500	0.4	0.6	4	30	400
7	2000	0.6	0.9	6	35	400
8	2500	0.8	1.2	8	50	400
10	3500	1.0	1.5	10	60	400
12	4500	1.2	1.8	12	75	400
15	5000	1.3	2.0	13	80	400
15	5000	1.2	1.8	12	80	400
15	5000	1.5	2.0	15	90	400
15	6000	1.7	2.5	17	100	400

5. There is evidence that the male adult needs relatively little iron. The need will usually be provided for if the diet is satisfactory in other respects.

6. The need for supplemental vitamin D by vigorous adults leading a normal life seems to be minimum. For persons working at night and for nuns and others whose habits shield them from the sunlight, as well as for elderly persons, the ingestion of small amounts of vitamin D is desirable.

7. During the latter part of pregnancy the calorie allowance should increase approximately 20 per cent above the preceding level. The value of 2400 calories represents the allowance for pregnant, sedentary women.

8. Allowances for children are based on the needs for the middle year in each group (as 2, 5, 8, etc.) and are for moderate activity and for average weight at the middle year of the age group.

9. Needs for infants increase from month to month with size and activity. The amounts given are for approximately 6 to 8 months. The dietary requirements for some of the nutrients such as protein and calcium are less if derived largely from human milk.

Fat. There is available little information concerning the human requirement for fat. Fat allowances must be based at present more on food habits than on physiological requirements. While a requirement for certain unsaturated fatty acids (the linoleic and arachidonic acids of natural fats) has been amply demonstrated with experimental animals, the human need for these same fatty acids is not known. In spite of the paucity of information on this subject there are several factors which make it desirable (1) that fat be included in the diet to the extent of at least 20 to 25 per cent of the total calories and (2) that the fat intake include essential unsaturated fatty acids to the extent of at least 1 per cent of the total calories. At higher levels of caloric expenditure, *e.g.*, for a very active person consuming 4500 calories and for children and for adolescent persons, it is desirable that 30 to 35 per cent of the total calories be derived from fat. Since foodstuffs such as meat, milk, cheese, nuts, etc., contribute fat to the diet, it is necessary to use separated or "visible" fats such as butter, oleomargarine, lard, or shortenings to supply only one-third to one-half the amounts indicated.

Water. A suitable allowance of water for adults is 2.5 liters daily in most instances. An ordinary standard for diverse persons is one milliliter for each calorie of food. Most of this quantity is contained in prepared foods. At work or in hot weather, requirements may reach 5 to 13 liters daily. Water should be allowed *ad libitum*, since sensations of thirst usually serve as adequate guides to intake except for infants and sick persons.

Salt. The needs for salt and for water are closely interrelated. A liberal allowance of sodium chloride for the adult is 5 grams daily, except for some persons who sweat profusely. The average normal intake of salt is 10 to 15 grams daily, an amount which meets the salt requirements for a water intake up to 4 liters daily. When sweating is excessive, one additional gram of salt should be consumed for each liter of water in excess of 4 liters daily. With heavy work or in hot climates 20 to 30 grams daily may be consumed with meals and in drinking water. Even then, most persons do not need more salt than usually occurs in prepared foods. It has been shown that after acclimatization persons produce sweat that contains only about 0.5 gram to the liter in contrast with a content of 2 to 3 grams for sweat of the unacclimatized person. Consequently after acclimatization, need for increase of salt beyond that of ordinary food disappears.

Iodine. The requirement for iodine is small, probably about 0.002 to 0.004 mg. daily for each kilogram of body weight, or a total of 0.15 to 0.30 mg. daily for the adult. This need is met by the regular use of iodized salt; its use is especially important in *adolescence* and *pregnancy*.

Phosphorus. Available evidence indicates that the phosphorus allowances should be at least equal to those for calcium in the diets of children and of women during the latter part of pregnancy and during lactation. In the case of other adults the phosphorus allowances should be approximately 1.5 times those for calcium. In general it is safe to assume that if the calcium and protein needs are met through common foods, the phosphorus requirement also will be covered, because the common foods richest in calcium and protein are also the best sources of phosphorus.

Copper. The requirement for copper for adults is about 1 to 2 mg. daily. Infants and children require approximately 0.05 mg. for each kilogram of body weight. The requirement for copper is approximately one-tenth that for iron. A good diet normally will supply sufficient copper.

Vitamin K. The requirement for vitamin K usually is satisfied by any good diet except for the infant *in utero* and for the first few days after birth. Supplemental vitamin K is recommended during the last month of pregnancy. When it has not been given in this manner, it is recommended for the mother preceding delivery or for the baby immediately after birth.

Folic Acid. Evidence for recognizing folic acid (pteroylglutamic acid, vitamin B_c, *L. casei* factor or vitamin M) as an essential human nutrient is presented in the text. (*See p. 18 of original publication for this material—Ed.*) The quantitative requirement cannot be closely estimated from evidence published to date.

OUR DAILY FOOD

The characteristics and amounts of basic foods needed for an adequate diet*

Milk and Milk Products

Recommended daily milk intake

Adults—1 pint.

Children—¾-1 quart.

Pregnant women—1 quart.

Nursing mothers—1½ quarts.

Milk products furnish very digestible forms of fat, carbohydrates and proteins. Milk proteins are of outstanding biological value. Milk also supplies calcium and other minerals, vitamin A (especially in cream) and riboflavin.

Fruits, Tomatoes, Raw Cabbage

One or more servings daily

Citrus fruits, tomatoes and raw cabbages are excellent sources of vitamin C.

Yellow-fleshed fruits provide vitamin A.

Dried fruits are good sources of iron.

Enriched, Restored, or Whole Grain Bread, Flour and Cereals

2 slices of bread at every meal
1 serving of whole grain cereal daily

Economical energy foods furnishing significant amounts of protein.

Important sources of iron and B-complex vitamins.

Potatoes and Sweet Potatoes

1 serving daily

White potatoes, cooked in their skins, provide iron, vitamin C, thiamine, riboflavin and nicotinic acid. They are economical energy foods.

Sweet potatoes are also good sources of vitamin A.

Leafy, Green and Yellow Vegetables

One or more servings daily

Dark green leaves, raw or properly cooked, supply iron, vitamin A, calcium and other minerals, thiamine, riboflavin, nicotinic acid and vitamin C.

Other green and deep-yellow vegetables are primarily sources of vitamin A.

Frequent use of *raw* vegetables is desirable, because of their higher vitamin content.

Meat, Poultry, Fish, Eggs, Legumes and Nuts

Meat, poultry or fish every day
Dried beans or peas twice a week
Four or more eggs a week

These foods provide protein, iron, phosphorus and other minerals; also varying amounts of thiamine, riboflavin and nicotinic acid. Eggs and liver also supply vitamin A.

Food Fats—Butter, Fortified Margarine, Etc.

2 to 3 level tablespoons daily

These fats are concentrated energy foods, and good sources of vitamin A. Fish liver oils are also rich in vitamin D.

Non-hardened fats contain certain essential unsaturated fatty acids.

Vitamin D Source

Children should be exposed to effective sunlight and should receive at least 400 units of D daily as fish oils, or D-concentrates, or from vitamin D milk. The need for supplemental vitamin D by vigorous adults leading a normal life seems to be minimal. However, at least 400 units daily are needed during pregnancy and lactation.

*See HENRY SHERMAN: "Foods; Their Values and Management," Columbia Univ. Press, New York (1946); and "Principles of Nutrition and Nutritive Values of Food," U.S.D.A. Misc. Pub. No. 546 (1944).

THE DIET IN HEALTH AND DISEASE

NUTRITIONAL science tells us what nutrients are necessary and where they are to be found. The art of the dietitian lies in using such data to assemble palatable combinations of foods supplying proper amounts of essential nutrients. It is only within recent years that this close liaison has come about. Many traditional special diets are needlessly complex and unscientific, and may even induce dietary deficiencies if continued over a long period of time.

Normal Diet

A normal dietary should provide adequate amounts of calories, proteins, fat, carbohydrate, minerals, vitamins, water and roughage, and the correct keto-antiketogenic ratio and acid-base balance. It should be attractive and enjoyable. The "Recommended Dietary Allowances" of the Food and Nutrition Board (p. 64) give quantitative optimal requirements for these dietary essentials. On p. 67 is a simple plan for meeting these needs in a daily diet.

The first requirement in diet therapy is to keep the patient in, or bring the patient to, a state of good nutrition. In planning a special diet, one should follow as closely as possible the normal, well-balanced diet, making the minimum of alterations. In certain closely restricted diets and in the therapy of frank malnutrition the use of concentrated vitamin and mineral preparations may be desirable; in general it is preferable to obtain a high intake of dietary essentials through the use of natural foods which are more likely to furnish both known and unknown nutrients.

Allergy

Although the maintenance of optimal nutritional intake and balance is the guiding principle of all dietetic planning, this must be combined with the application of the best clinical experience and common sense in treating special conditions and individual cases. The allergic individual, for example, may present special problems. Patients showing few sensitivities and a wide inherent tolerance for foods may be easily treated by avoidance of the offending food(s). With an unusual sensitivity to many foods, and therefore a reduced tolerance for the general run of foods, the patient may become sensitized to any article of the diet if it is used too frequently and consistently. Such patients are best controlled by feeding a wide variety of tolerated foods, rotating them in the diet, and avoiding the frequent use of foods botanically related to known allergic offenders.

Obesity

Reduction of excess body weight requires strict caloric control. It is necessary to reduce caloric intake below caloric expenditure. This is best done by a reduced normal diet, with a lower amount of fat, and a minimum of concentrated carbohydrates. Provision should be made for an adequate vitamin supply, and sufficient (cellulosic) bulk to allay hunger. Many reducing diets published in the lay press seem almost calculated to produce dietary deficiencies, as well as loss in weight. Metabolic stimulants, such as thyroid preparations or benzedrine (amphetamine) can be useful in the management of recalcitrant cases, but only under the strictest medical supervision. Otherwise they can be harmful or dangerous.

Underweight

Underweight is one of the most obvious signs of malnutrition. It may be produced by a diet lacking in various essential dietary factors and/or sufficient caloric intake to balance energy expenditure. In the first case the missing dietary factors must be supplied. The second type requires increased caloric intake. In general, the diet should be more concentrated, and planned to provide the needful calories before the point of satiety is reached. Supplemental feedings between regular meals and before retiring may aid in this. Fats and carbohydrates should be stressed; excess protein avoided.

Patients may be found who do not gain weight

on what seems to be an adequate diet. The section on "Conditioning Factors in Nutritional Disease" (p. 43) lists a number of possible reasons for this condition. Its use may be helpful in such cases.

Thyroid Disease

Diseases of the thyroid gland, a major metabolic regulator, require careful control of the caloric content of the diet. In *hyperthyroidism*, the increase in metabolic rate, as well as the excess activity, necessitate increased food intake. The decreased metabolic activity of *hypothyroidism* lowers energy requirements. Care must be taken to prevent deficiencies in essential nutrients arising from the patient's disinclination to eat. There is evidence of increased need for vitamins A, C and several members of the B-complex in hyperthyroidism.

Diabetes

Diets used in the therapy of diabetes mellitus have included most of the possible permutations of fats, proteins, and carbohydrates. A popular formula before the use of insulin was carbohydrate, 50 grams; protein, 50 grams; and fat, 150 grams. As insulin became available, the carbohydrate content was increased and the fat content lowered. By 1926 Sansum had advocated 2 grams of carbohydrate to 1 gram of fat for the average diabetic, and three or more times as much carbohydrate as fat for diabetic children. Other diets have ranged from this to the low carbohydrate and protein, high fat diet of Newburgh and Marsh, with the Joslin diet a happy medium.

The diabetic diet is planned around a caloric intake of 25–30 calories per kilogram of body weight per day; the lower figure being used for elderly or bed patients, and the higher for young, growing, or physically active patients. This figure is modified, in accordance with later weight changes, to bring the patient to a body weight promising maximal longevity. Slight caloric undernutrition should be maintained. Adults require from ¾ to 1 gram of protein per kilo. per day; children somewhat more. The choice between a low fat level (40% of total calories) and a high fat level (60%) is determined by the judgment of the physician and the preference of the patient. It is difficult to prepare a satisfactory daily menu with less than 90 grams of fat in it. Very high fat levels may produce slight ketosis.

When the protein and fat content of the diet are decided on, the carbohydrate level is adjusted to meet the remaining caloric requirements. Insulin is prescribed in the necessary dosage, if possible given once daily, to enable the patient to remain free of urinary sugar, while avoiding both hyper- and hypo-glycemia. The modern diabetic diet varies from the normal by a decrease in concentrated carbohydrate and an increase in all vegetables, especially "green" vegetables. The total food intake is adjusted to a level compatible with normal life without overtaxing the impaired mechanism.

Fevers

The increased metabolic rate of febrile conditions requires, in addition to a high fluid intake, additional amounts of calories, proteins, vitamins, and minerals. Liver and gall-bladder disease call for a diet low in fat and high in carbohydrate. The carbohydrate protects the liver cell by glycogen formation; the low fat content minimizes gall-bladder stimulation. Renal and cardiovascular disease need diets meeting all essential requirements, as dietary regulation is usually maintained for long periods. Tissue and blood proteins must be maintained at normal levels, and water and sodium chloride intake closely regulated, if edema is to be avoided. The diet should require a minimum of work for the diseased organs. This may be done by restricting protein intake and body weight.

Gastrointestinal Disease

Two types of diet are used in the management of gastrointestinal diseases; those which will rest, and those which will stimulate, the affected part. The first type is the smooth or bland diet. In acute stages this may take the form of a liquid or *Sippy* (essentially milk and cream) diet. Less serious cases may be given a modified normal diet, characterized by the complete

absence of roughage. This is obtainable by the use of a grinder and sieve; or by feeding various strained infant foods. The smooth diet becomes bland by the elimination of condiments and alcohol. As a rule, organic lesions of the gastro-intestinal tract require such dietary therapy.

Patients with poor tonus of the intestinal musculature require a variant low in bulk and high in concentration. Those with pure neuro-muscular atony (poor peristaltic action) require a diet high in roughage and/or bulk. It may be necessary to attain such a diet with the use of bulk-formers, such as agar, psyllium seed or flaxseed, or gelatin. Supplementation with commercial vitamin products (*i.e.*, B-complex and C) is usually necessary.

Surgery

Surgical patients require dietary attention both pre- and post-operatively. The general nutritional state of the patient should be brought to normal before operation. Immediately before surgery the load on the patient's digestive tract is lightened. Post-operative dietaries are planned to facilitate the return to normal eating habits. The precise diet selected depends on the nature of the operation, etc. The transition is from starvation, to liquid, to soft diet, and finally, for the convalescent, a normal diet.

Acute Disease

The natural reaction to acute disease is to refuse food and fluid. In such cases it may be necessary to resort to gastric gavage, nutrient enemas, subcutaneous infusions, or intravenous administration. Recent developments make it possible to give carbohydrate, protein (as hydrolysates or amino acids), fat (as an emulsion), vitamins and minerals intravenously, and thus to maintain complete, albeit expensive nutrition. *Liquid* diets are based on milk, with various additives. The *semi-solid* diet may be eaten with a fork or spoon, but requires no chewing. Strained and chopped infant foods are useful in planning such diets. The *convalescent* diet is a high quality normal diet, containing no foods difficult to digest. Pastries and fried foods are contraindicated. The amount of roughage contained varies with the disease being treated, and can be controlled by the use of the grinder and sieve.

Pregnancy and Lactation

The primary concern in planning diets for pregnancy is the health of the mother, since the fetus will rob needed nutrients from its parent. The caloric needs are not altered until the 4th or 5th month; they then gradually increase until by the 9th month they are about 25% greater. Care should be taken to provide ample amounts of protein of high biological value, calcium, phosphorus, iron, iodine, and vitamins. The mother's increase in weight should not be more than 1 pound every 2 weeks, or a total of 16 pounds.

Lactation places an additional burden on the system. Because of the inefficiency of conversion, the diet must provide more food than is actually used by the mother and child. The total food consumption during this period should be about 60% more than that of late pregnancy. The needs of both pregnancy and lactation may be met in large part by a generous supply of protective foods, but vitamin and mineral supplements will also be required.

Feeding of Infants and Children

The nutritional needs are greater in infancy than any other time of life. During the first few months about 120 calories per kilo. per day are needed. From 2 to 3.5 g. of protein per kilo. per day is needed; before the 4th or 5th month this is obtained from milk. About 40% of the calories are furnished by carbohydrate; up to 50 per cent may be furnished by fat. It is usually necessary to supplement the infant dietary with concentrated forms of iron, and vitamins A, B-complex, C and D. The tendency in modern pediatric practice has been to start feeding solid foods at an early age. Cereal is traditionally the first solid food; it is followed in rapid succession by egg yolk, vegetables, fruits and meats. These are served in strained form, to facilitate splitting by the comparatively weak digestive enzymes of the infant. The diet of the growing child is merely an adaptation of the normal adult diet. It is necessarily somewhat higher in protein and calcium, both supplied by the additional milk consumed. It must also be

higher in fat, to meet the relatively higher caloric requirements. Specially prepared "chopped" or "junior" foods facilitate the transition from infant to adult diets.

It is believed that the charts on the Composition of Foods, pages 73 to 93, will be useful in determining whether normal and specific diets meet adequately all nutritional requirements. It is beyond the scope of NUTRITIONAL DATA to include specific diet lists. These may be obtained from the reference works listed in the bibliography accompanying this section.

Selected Readings

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CONSERVATION OF NUTRITIVE VALUE OF FOODS

General[1]

TABLES on the composition and nutritive values of foods usually are based on data obtained from uncooked foods. The nutritive values of cooked foods may differ markedly from those of raw foods. This is especially true of their vitamin content, which may be affected by losses from solubility, oxidation, heat destruction and light. These losses differ with the individual vitamins and foods, and no one factor is generally applicable.

Various methods of cooking meats, such as roasting, broiling, frying, braizing and stewing have been studied as to their effects on vitamin content. Varying with the type of heat applied, thiamine retention ranged from 60–80%, riboflavin 80–100%, and nicotinic acid 70–100%. Similar studies with vegetables showed thiamine retentions of 55–70% and riboflavin retentions of 50–100%. Complete details of the factors and the conditions by which they were obtained are given in a National Research Council Food and Nutrition Board Report.[2]

Several important principles in the conservation of nutrients are equally applicable to food processing in the home and in the factory.

1. Vegetables and fruits should not be prepared or trimmed long before they are cooked.
2. Blanching or boiling in excessive amounts of water should be avoided. Dissolved minerals are lost when cooking water is discarded.
3. Thiamine and ascorbic acid are best preserved in acid solutions. Sodium bicarbonate should not be used in cooking.
4. Vegetables should not be overcooked. Most foods are more easily digestible and have better color, flavor and texture if cooked only till moderately tender.
5. Oxidation will destroy ascorbic acid and vitamin A, or its provitamin, carotene. A vegetable to be boiled should be dropped in actively boiling water, to destroy quickly any oxidizing enzymes, and to minimize dissolved oxygen in the cooking water. Vacuum processes are desirable in food manufacture.
6. There is a close correlation between the nutritive value of fruits and vegetables and other attributes which contribute to quality or taste appeal. Conditions of storage and preparation which best retain color, flavor, aroma and texture tend, also, to preserve nutritive value.

Effect of Manufacturing Processes

Canning[3]

Modern canning procedures are efficient in retaining the vitamin and mineral content of the starting materials. Storage studies on canned foods stored at elevated temperatures indicate substantial maintenance of the nutrients in these products. A goodly fraction of the water soluble vitamins, *e.g.*, ascorbic acid, thiamine and riboflavin, is present in the liquid portion of the can. Consequently, it is highly desirable to utilize the entire contents of the can, especially with canned vegetables.

Freezing

The process for preparing and blanching foods for commercial quick-freezing are similar to those employed by the canning industry. When the best available procedures are followed, the vitamin retention in frozen foods stored at 0° F., or lower, is very good.

Dehydration

Drying is more destructive of vitamins than is any other process. This is particularly true for ascorbic acid. Vitamin A and carotene may also be partly destroyed during dehydration. Further losses may occur during storage unless the product is properly packed.

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1. "The Effect of Processing Upon the Nutritive Value of Food"; VAIL: *J. Amer. Diet. Assoc.* **18**, 569 (1942).
2. "Tables of Vitamin Retention in Large Scale Cookery"; prepared by the Committee on Food Composition of the Food and Nutrition Board (1946).
3. "Nutrient Retention in Canning"; CAMERON, PILCHER and CLIFCORN, *Information Letter* #1219, National Canners' Association, Jan. 26 (1949).

TABLES OF COMPOSITION AND NUTRITIVE VALUE OF FOODS

The data in the following tables have been gleaned from the sources given below:

"Proximate Composition of American Food Materials": Chatfield, C., and Adams, G., U. S. Dept. of Agriculture Circular No. 549 (1940).

"Food Values in Shares and Weights": Taylor, C. M., The Macmillan Company, New York (1942).

"Tables of Food Composition in Terms of Eleven Nutrients": U. S. Department of Agriculture Misc. Pub. No. 572 (1945).

"Table of Food Values Recommended for Use in Canada": Nutrition Division, Dept. of National Health and Welfare, Ottawa, Canada (1946).

"Food Value Tables for Calculation of Diet Records": Boyd, E. F., Eads, M. G., and Sandstead, H. R.; U. S. Public Health Service, Federal Security Agency (1947).

"The Canned Food Reference Manual" 3rd Ed.: American Can Co. (1947).

"Canned Food Tables": National Canners Assoc. (1948).

"Canned Foods in the Nutritional Spotlight": National Canners Assoc.—Can Manufacturers Institute (1948).

We wish to express our gratitude to those whose compilations have made our own task simpler. For easier use, we have avoided cluttering our tables with reference numbers; we shall be glad to give the source of any figures of interest to our readers.

The nutrient content of foods has been indicated by single figures, not by ranges. Since these figures generally represent averages of other tables, which in turn are also averages, the data following can at best be regarded as estimates of composition. Although they are adequate for preliminary calculations of diets, very precise work would seem to require laboratory analyses of the individual foods as consumed.

DAIRY

Constituents of 100

NAME	PROXIMATE COMPOSITION							MINERALS	
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbohydrates g.	Crude Fiber g.	Calcium mg.	Phosphorus mg.
Butter	733	15.5	.6	81.0	2.5	.4	...	16	16
Buttermilk, cultured	35	90.5	3.5	.1	.8	5.1	...	118	93
Cheese, Cheddar type	393	39.0	23.9	32.3	3.1	1.7	...	873	610
Cheese, cottage	101	74.0	19.2	.8	1.7	4.3	...	82	263
Cheese, cream	367	53.3	7.1	36.9	1.0	1.7	...	298	208
Cheese, Roquefort	391	37.4	21.7	33.2	6.3	1.4	...	698	529
Cheese, Swiss	404	34.0	28.6	31.3	4.2	1.9	...	1100	811
Cheese, processed, canned	382	37.5	21.9	31.8	5.8	2.0	...	716	831
Cream, sweet or sour	208	72.5	2.9	20.0	.6	4.0	...	97	77
Ice cream, plain	210	62.0	4.0	12.3	.8	20.8	...	132	104
Milk, chocolate flavored	75	90.5	3.5	.1	...	5.1	...	118	93
Milk, condensed, sweetened	327	27.0	8.1	8.4	1.7	54.8	...	273	228
Milk, dry skim	359	3.5	35.6	1.0	7.9	52.0	...	1300	1030
Milk, dry whole	496	3.5	25.8	26.7	6.0	38.0	...	949	728
Milk, evaporated, unsweetened	139	73.7	7.0	7.9	1.5	9.9	...	243	195
Milk, fresh skim	35	90.5	3.5	.1	.8	5.1	...	118	93
Milk, fresh whole	69	87.0	3.5	3.9	.7	4.9	...	118	93

FATS, OILS, AND

Constituents of 100

NAME	PROXIMATE COMPOSITION							MINERALS	
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbohydrates g.	Crude Fiber g.	Calcium mg.	Phosphorus mg.
Bacon, medium fat	626	20.0	9.1	65	4.7	1.1	...	13	108
Butter	733	15.5	.6	81	.4	.4	...	16	16
French dressing	423	38.3	.8	39	4.6	17.3	.4	5	5
Lard, other shortenings	900	.0	.0	100	.0	.0	.0	0	0
Margarine, added vitamin A	733	15.5	.6	81	2.5	.4	.0	2	15
Mayonnaise	720	16.0	1.5	78	1.5	3.0	...	19	60
Salad dressing	391	44.7	1.1	37	3.5	13.9	...	9	30
Salad or cooking oil	900	.0	.0	100	.0	.0	...	0	0
Salt pork, fat	781	8.0	3.9	85	3.5	.0	...	2	42

PRODUCTS

Grams of Edible Portion

MINERALS		VITAMINS					AVERAGE PORTION		
Iron mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in Grams
.20	.03	3,300	*trace*	.01	.1	0	100	1 tbsp.	15
.07	....	*trace*	.04	.18	.1	1	84	1 cup	240
.57	.05	1,740	.04	.50	.2	0	79	1″ cube	20
.46	....	30	.02	.29	.1	0	45	2½ tbsp.	45
.17	....	2,210	.01	.14	.1	0	110	2 tbsp.	30
1.00	....	4,020	.03	.45	1.2	....	175	1 sector	45
1.20	....	1,980	.03	.52	.1	....	101	1 slice	25
.76	....	1,260	.03	.43	.1	0	....	.....	..
.06	.15	830	.03	.14	.1	1	62	2 tbsp.	30
.10	....	540	.04	.19	.1	*trace*	210	½ cup	100
.07	....	*trace*	.04	.18	.1	1	184	1 cup	245
.20	....	430	.05	.39	.2	1	327	⅓ cup	100
.58	....	40	.35	1.96	1.1	7	36	1 tbsp.	10
.58	.15	1,400	.30	1.46	.7	6	40	1 tbsp.	8
.17	.07	400	.05	.36	.2	1	180	½ cup	130
.07	....	*trace*	.04	.18	.1	1	84	1 cup	240
.07	.02	160	.04	.17	.1	1	165	1 cup	240

SHORTENINGS

Grams of Edible Portion

MINERALS		VITAMINS					AVERAGE PORTION		
Iron mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in Grams
.8	....	0	.26	.10	1.5	0	....	.....	..
.2	....	3,300	*trace*	.01	.1	0	100	1 tbsp.	13
.1	....	0	.00	.00	.0	0	50	1 tbsp.	11
.0	....	0	.00	.00	.0	0	100	1 tbsp.	11
.2	....	1,980	.00	.00	.0	0	100	1 tbsp.	13
1.0	....	210	.04	.04	.0	0	100	1 tbsp.	14
.4	....	140	.02	.03	.0	0	86	1 tbsp.	22
.0	....	0	.00	.00	.0	0	....	.....	..
.6	....	0	.18	.04	.9	.0	....	.....	..

FRUITS

Constituents of 10

NAME	PROXIMATE COMPOSITION							MINERALS	
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbohydrates g.	Crude Fiber g.	Calcium mg.	Phosphorus mg.
BERRIES									
Blackberry	62	85.3	1.2	1.1	.47	11.9	4.1	17	34
Blueberry or huckleberry	68	83.4	.6	.6	.28	15.1	1.2	16	13
Cranberry	53	87.4	.4	.7	.20	11.3	1.4	12	10
Currant, red	61	84.7	1.6	.4	.61	12.7	3.2	26	38
Gooseberry, American	47	88.3	.8	.4	.39	10.1	2.5	19	19
Loganberry	69	82.9	1.0	.6	.52	15.0	1.4	35	24
Raspberry, black	83	80.7	1.5	1.6	.65	15.6	3.5	58	..
Raspberry, red	67	83.4	1.1	.6	.47	14.4	2.8	49	52
Strawberry, American	41	90.0	.8	.6	.50	8.1	1.2	28	27
CITRUS FRUITS									
Grapefruit	44	88.8	.5	.2	.42	10.1	.3	17	18
Lemon	44	89.3	.9	.6	.54	8.7	.9	14	10
Lime	53	86.0	.8	.1	.80	12.3	...	14	10
Orange	50	87.2	.9	.2	.47	11.2	.6	33	23
Tangerine	50	87.3	.8	.3	.66	10.9	1.0	33	23
MELONS									
Cantaloupe	23	94.0	.6	.2	.60	4.6	.6	17	16
Honey dew	36	90.6	.6	.2	.60	5.9	.5	17	16
Watermelon	31	92.1	.5	.2	.27	6.9	.6	7	12
TREE, VINE AND OTHER FRUITS									
Apple	64	84.1	.3	.4	.29	14.9	1.0	6	10
Apricot	56	85.4	1.0	.1	.59	12.9	.6	16	23
Apricot, canned unpeeled	86	77.9	.5	.2	.53	20.5	.4	8	16
Apricot, dried	292	24.0	5.2	.4	3.50	66.9	3.2	86	119
Avocado	265	65.4	1.7	26.4	1.42	5.1	1.8	10	38
Banana	99	74.8	1.2	.2	.84	23.0	.6	8	28
Cherry, sweet	80	80.0	1.1	.5	.60	17.8	.4	18	31
Date, dried	316	20.0	2.2	.6	1.80	75.4	2.4	72	60
Fig, canned	125	68.5	.8	.3	.40	30.0	.9	35	21
Fig, dried	300	24.0	4.0	1.2	2.40	68.4	5.8	223	104
Grape	74	81.6	.8	.4	.46	16.7	.5	17	21
Olive, green	144	75.2	1.5	13.5	5.80	4.0	1.2	101	15
Olive, ripe (pickled)	189	73.4	1.6	19.0	3.00	3.0	1.9	105	14
Peach, yellow, fresh	51	86.9	.5	.1	.47	12.0	.6	8	22
Peach, yellow, canned	86	77.9	.5	.1	.33	20.8	.4	4	12
Peach, dried	295	24.0	3.0	.6	3.00	69.4	3.5	60	120
Pear, fresh	70	82.7	.7	.4	.39	15.8	1.4	13	16
Pear, canned	75	80.7	.3	.1	.20	18.1	.7	6	7
Pineapple, fresh	58	85.3	.4	.2	.42	13.7	.4	16	11
Pineapple, canned	102	74.0	.4	.2	.37	24.7	.3	20	8
Plum, fresh	56	85.7	.7	.2	.51	12.9	.5	17	20
Prune, dried	299	24.0	2.3	.6	2.10	71.0	1.6	54	85
Raisin, seeded	298	24.0	2.3	.5	2.00	71.2	...	78	129

FRUITS

rams of Edible Portion

MINERALS		VITAMINS					AVERAGE PORTION		
Iron mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in Grams
								BERRIES	
1.0	.16	90	.03	.04	.3	3	50	½ cup blackberries	80
.8	.11	280	.03	.07	.3	16	45	½ cup blueberries	67
.5	.09	40	...	.02	.1	14	26	¼ cup, cooked	50
.6	...	380	.04	...	...	40	34	½ cup currants	55
.6	.15	120	...	...	...	16	33	½ cup gooseberries	70
1.4	.14	...	.03	...	...	30	50	½ cup loganberries	72
...	...	*trace*	...	....	...	66	56	½ cup raspberries	68
1.0	.13	260	.02	.06	...	23	47	½ cup raspberries	70
.8	.02	60	.03	.07	.3	60	40	½ cup strawberries	102
								CITRUS FRUITS	
.3	.03	*trace*	.04	.02	.2	40	83	½ medium grapefruit	286
.1	.04	0	.04	*trace*	.1	45	6	1 tbsp. lemon juice	15
.1	...	0	.04	*trace*	.1	27	...	Lime	...
.4	.31	190	.08	.03	.2	49	56	1 medium orange	156
.4	.09	420	.07	.03	.2	31	40	1 whole tangerine	114
								MELONS	
.4	.06	3420	.06	.04	.8	33	23	½ cup cantaloupe balls	100
.4	.07	10	.05	...	...	20	24	½ cup honey dew balls	67
.3	.07	590	.05	.05	.2	6	46	1 slice watermelon	331
								TREE, VINE AND OTHER FRUITS	
.3	.10	90	.04	.02	.2	5	72	1 medium apple	127
.5	.14	2790	.03	.04	.7	4	94	5 apricots	177
.7	...	2160	.02	.02	.3	4	105	4 med. halves+2 T. sirup	122
4.9	.37	7430	.01	.16	3.3	12	350	½ cup cooked apricots	120
.6	.21	290	.12	.15	1.1	16	177	⅓ avocado	76
.6	.21	430	.09	.06	.6	10	100	1 medium banana	100
.4	.14	190	.05	...	...	9	100	20 cherries	134
2.1	...	180	.08	.04	2.2	...	100	4 dates (stoned)	29
.4	...	75	.09	.08	...	...	...	Fig, canned	...
3.1	.35	70	.13	.10	1.7	...	100	2 medium figs	32
.6	.06	80	.05	.03	.4	4	92	25-30 grapes (malaga)	128
2.0	...	420	...	...	...	...	30	2 large or 4 small olives	27
.4	.34	...	...	...	...	...	...	Olive, ripe	...
.6	.01	880	.02	.05	.9	8	45	1 medium peach	100
.3	...	330	.01	.02	.5	3	101	2 med. halves & 2 T. sirup	117
6.1	.27	...	...	...	...	...	...	Peach, dried	...
.3	.10	20	.02	.04	.1	4	45	1 medium pear	79
.5	...	...	.01	.02	.2	2	88	2 med. halves & 2 T. sirup	117
.3	.07	130	.08	.02	.2	24	50	1 slice pineapple	87
.7	...	50	.07	.02	.2	5	124	2 small or 1 large slice and 2 T. sirup	122
.5	.15	350	.15	.03	.6	5	25	1 plum	45
3.9	.41	1890	.10	.16	1.7	3	84	4 medium prunes	33
3.3	.20	50	.15	.08	.5	*trace*	85	¼ cup raisins (seeded)	29

FRUIT JUICES AND

Constituents of 10

NAME	PROXIMATE COMPOSITION							MINERALS	
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbohydrates g.	Crude Fiber g.	Calcium mg.	Phosphorus mg.
Apple juice	50	87.1	.1	.0	.25	12.5	...	3	6
Apple sauce	80	79.8	.2	.1	.20	19.7	.60	4	6
Apricot nectar	52	86.1	.3	.1	.50	12.4	.20	9	13
Grape juice, canned	72	81.2	.3	.2	.20	17.3	.00	7	10
Grapefruit juice, canned	44	88.7	.5	.1	.38	10.3	.04	8	13
Grapefruit segments, canned	77	80.2	.6	.1	.38	18.5	.23	13	14
Orange juice, fresh	55	85.7	.6	.0	.58	13.1	...	25	19
Orange juice, canned	49	87.6	.8	.2	.46	10.9	.03	10	19
Orange and grapefruit blend, canned	41	88.2	.5	.1	.40	9.6	.00	9	16
Pineapple juice, canned	59	84.9	.4	.1	.37	14.2	.08	15	9
Prune juice	76	80.3	.4	.1	.60	18.3	.00	18	21
Tomato juice, canned	21	93.7	.8	.1	1.14	4.1	.17	7	18

NUTS AND

Constituents of 10

NAME	PROXIMATE COMPOSITION							MINERALS	
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbohydrates g.	Crude Fiber g.	Calcium mg.	Phosphorus mg.
Almonds	640	4.7	18.6	54.1	3.0	19.6	2.7	254	475
Brazil	695	5.3	14.4	65.9	3.4	11.0	2.1	124	602
Cashew	609	4.1	19.6	47.2	2.7	26.4	1.0	48	480
Chestnut, fresh	191	53.2	2.8	1.5	1.0	41.5	1.1	48	48
Coconut, dried	579	3.3	3.6	39.1	.8	53.2	4.1	43	191
Peanut butter	619	1.7	26.1	47.8	3.4	21.0	2.0	74	393
Peanut, roasted	600	2.6	26.9	44.2	2.7	23.6	2.4	74	393
Pecans	747	3.0	9.4	73.0	1.6	13.0	2.2	74	324
Walnuts, black	672	2.7	18.3	58.2	2.1	18.7	1.9	...	...
Walnuts, English	702	3.3	15.0	64.4	1.7	15.6	2.1	83	380

OTHER FRUIT PRODUCTS

rams of Edible Portion

MINERALS		VITAMINS					AVERAGE PORTION		
Iron mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in grams
.9	....	...	.010	...	.10	2	59	4 oz.	117
.2	...	60	.010	.01	*trace*	1	100	½ cup	126
3.3	.13	1086	.007	.01	.26	2	...	.....	...
.2	.17	0	.014	.01	.18	4	90	4 oz.	125
.4	...	15	.035	.02	.17	33	50	4 oz.	113
.3	...	15	.035	.02	.21	25	87	½ cup	113
.3	.08	200	.110	.06	.20	59	67	4 oz.	122
.5	...	160	.074	.02	.24	37	55	4 oz.	113
.1	.06	69	.056	.01	.15	33	47	4 oz.	113
.3	...	50	.052	.02	.18	9	67	4 oz.	113
3.4	.07	0	.006	.01	.46	4	87	4 oz.	113
.9	...	860	.055	.03	.77	15	24	4 oz.	113

NUT PRODUCTS

rams of Edible Portion

MINERALS		VITAMINS					AVERAGE PORTION		
Iron mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in grams
4.4	1.21	0	.25	.67	4.6	*trace*	90	12 almonds	14
2.8	1.39	50	.03	...	....	10	96	2 Brazil nuts	14
...	....	..	.66	.19	....	..	85	10 cashew nuts	14
4.1	.06	0	.08	.24	1.0	0	26	3 chestnuts	14
3.6	....	0	*trace*	*trace*	*trace*	0	81	2 tbsp.	14
1.9	....	0	.20	.16	16.2	0	105	1 tbsp.	17
1.9	....	0	.30	.16	16.2	0	84	16 peanuts	14
2.4	1.36	50	.72	.11	1.2	2	106	12 pecans	14
6.0	....	130	.33	...	....	0	94	12 meats	14
2.1	1.00	30	.48	.13	1.2	3	98	12 meats	14

Constituents of 10

NAME	PROXIMATE COMPOSITION							MINERALS	
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbo-hydrates g.	Crude Fiber g.	Calcium mg.	Phos-phorus mg.
BREAKFAST CEREALS									
Corn flakes	359	9.3	7.9	.7	1.8	80.3	.5	10	56
Oatmeal (rolled oats)	396	8.3	14.2	7.4	1.9	68.2	1.2	54	365
Rice flakes, puffed rice	363	8.8	7.2	.4	1.0	82.6	.5	9	92
Wheat cereals									
Farina, enriched	359	11.0	11.5	1.0	.4	76.1	.3	21	125
Flakes, puffed wheat	372	6.2	11.9	1.5	2.6	77.7	1.7	33	353
Shredded wheat	369	7.7	10.4	1.4	1.8	78.7	2.1	38	385
Whole grain, uncooked	368	8.7	11.7	2.0	1.8	75.8	1.8	38	385
OTHER CEREALS									
Barley, pearled, light	357	11.1	8.2	1.0	.9	78.8	.5	16	189
Hominy, raw	357	11.4	8.5	.8	.4	78.9	.4	11	70
Macaroni; spaghetti	360	11.0	13.0	1.4	.7	73.9	.4	22	144
Noodles, egg	385	9.1	14.3	5.0	1.0	70.6	.3	24	156
Rice: Brown	356	12.0	7.5	1.7	1.1	77.7	.6	39	303
Converted	351	12.3	7.6	.3	...	79.4	...	9	92
White	351	12.3	7.6	.3	.4	79.4	.2	9	92
Tapioca	350	12.6	.6	.2	.2	86.4	.1	12	12
Wheat bran	354	10.1	16.6	3.7	6.1	63.5	10.3	77	1336
Wheat germ	389	11.0	25.2	10.0	4.3	49.5	2.5	84	1096
Wheat, whole	360	11.0	13.0	2.0	1.8	75.8	1.8	38	385
FLOUR; MEAL									
Corn germ	445	9.1	14.5	20.8	5.7	49.9	5.1	..	..
Corn meal:									
White, degerminated	355	12.0	7.5	1.1	.6	78.8	.8	10	140
White, whole grain	365	12.0	9.1	3.7	1.3	73.9	2.0	18	248
Yellow, degerminated	356	12.0	8.3	1.2	.5	78.0	.7	10	140
Yellow, whole grain	365	12.0	9.1	3.7	1.3	73.9	2.0	18	276

RODUCTS

ams of Edible Portion

MINERALS		VITAMINS					AVERAGE PORTION		
on mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in Grams
								BREAKFAST CEREALS	
.0	.17	0	.16	.08	1.6	0	75	1 cup corn flakes	21
.2	.50	0	.55	.14	1.1	0	100	¾ cup cooked, ¼ cup uncooked oatmeal	136
.9	.56	0	.05	.03	1.4	0	45	1 cup rice flakes	12
.3	29	0	.37	.26	1.3	0	100	1 cup farina	170
.7	....	0	.15	.12	4.2	0	48	1 cup puffed wheat	13
.8	....	0	.20	.14	4.2	0	100	1 shredded wheat biscuit	27
.8	.72	0	.45	.13	4.6	0	100	¾ cup cooked, ⅓ cup uncooked wheat	170
								OTHER CEREALS	
.0	.12	0	.12	.08	3.1	0	50	1 tbsp. barley	14
.0	.19	0	.15	.05	.9	0	100	¾ cup, cooked	193
.2	....	0	.13	.08	2.1	0	100	¾ cup, cooked	163
.9	....	200	.13	.12	2.1	0	100	¾ cup, cooked	163
.5	.36	0	.29	.05	4.6	0	100	¾ cup steamed rice	113
.7	.19	0	.23	.04	3.8	0	107	¾ cup cooked rice	113
.7	.19	0	.05	.03	1.4	0	107	¾ cup cooked rice	113
.0	....	0	.00	.00	.0	0	140	¼ cup tapioca	40
.7	1.00	140	.52	.35	3.2	...	100	1 cup wheat bran	28
.1	....	0	2.05	.80	4.6	0	30	1 tbsp. wheat germ	8
.8	....	0	.56	.12	5.6	0	72	2 tbsp. whole wheat	20
								FLOUR; MEAL	
...	...	...	...	...	...	...	...	Corn germ	..
								Corn meal:	
.0	...	0	.16	.09	.0	0	...	White, degerminated	..
.7	...	0	.41	.12	1.7	0	...	White, whole grain	..
.0	.20	300	.15	.06	.9	0	...	Yellow, degerminated	..
.7	...	510	.45	.17	2.1	0	...	Yellow, whole grain	..

GRAIN PRODUCT

Constituents of 10

NAME	PROXIMATE COMPOSITION							MINERALS	
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbo-hydrates g.	Crude Fiber g.	Calcium mg.	Phos-phorus mg.
Flour:									
Buckwheat, light	354	12.0	6.3	1.1	.9	79.7	.4	11	88
Rye, light	358	11.0	8.9	.9	.7	78.5	1.1	18	278
Rye, whole grain	361	10.0	11.2	1.7	1.9	75.2	2.0	61	369
Soy, medium fat	283	9.0	42.5	6.5	5.0	13.6	2.5	244	610
Wheat, patent	355	12.0	10.8	.9	.4	75.9	.3	19	93
Wheat, patent, enriched	355	12.0	10.8	.9	.4	75.9	.3	19	93
Wheat, whole	360	11.0	13.0	2.0	1.6	72.4	.9	38	385
BAKED GOODS									
Bread:									
Rye, light	263	37.6	6.4	3.4	1.8	51.7	.5	22	96
White, enriched	261	35.9	8.5	2.0	1.6	52.3	.3	56	100
Whole wheat	262	37.0	9.5	3.5	2.0	48.0	1.0	60	370
Cake, light batter type	327	26.8	6.4	8.2	1.6	57.0	.1	62	126
Cookies, assorted, plain	438	4.8	6.0	12.7	1.9	75.0	.3	22	65
Cracker meal, crackers, assorted	422	4.5	9.5	10.3	2.4	72.7	.2	22	102
Crackers, graham	419	5.5	8.0	10.0	2.2	74.3	.8	20	203
Doughnuts	426	18.7	6.6	21.0	1.0	52.7	.2	45	83
Fig bars	363	13.8	4.2	4.8	1.4	75.8	1.7	69	69
Pie, apple	266	....	2.9	9.6	...	42.0	...	11	22
Pie, cream	223	....	2.8	9.8	...	31.0	...	20	38
Pretzels	362	8.0	8.8	3.2	5.5	74.5	.3	37	130
Rolls, plain, enriched	304	29.4	8.2	6.1	2.2	54.1	...	56	100
Rolls, sweet, enriched	304	29.6	7.8	5.4	2.2	56.0	...	56	100

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ams of Edible Portion

MINERALS		VITAMINS					AVERAGE PORTION		
ron mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in Grams
								Flour:	
.0	.07	0	.31	.08	2.1	0	...	Buckwheat, light	..
.3	...	0	.15	.07	.9	0	...	Rye, light	..
.8	.42	0	.47	.21	1.7	0	...	Rye, whole grain	..
.0	...	110	.82	.34	2.6	0	...	Soy, medium fat	..
.7	...	0	.07	.03	.8	0	...	Wheat, patent	..
.9	...	0	.44	.26	3.5	0	...	Wheat, patent, enriched	..
.8	...	0	.56	.12	5.6	0	...	Wheat, whole	..
								BAKED GOODS	
.8	.28	0	.16	.04	1.1	0	75	1 slice rye bread	28
.8	.34	0	.24	.15	2.2	0	60	1 slice white bread	23
.6	...	0	.28	.15	3.5	0	75	1 slice whole wheat	28
.0	...	0	.03	.10	.7	0	100	1 slice cake	30
.6	...	0	.04	.04	.5	0	100	1 cookie	23
.5	...	0	.07	.00	.6	0	25	1 cracker, 2¾″	6
.9	...	0	.30	.12	1.5	0	40	1 cracker, 2¾″	10
.9	...	190	.28	.22	2.0	0	213	1 doughnut, 3″	50
.3	...	0	.02	.06	.9	0	100	1 fig bar	28
.9	...	0	.05	.04	.4	0	266	1 sector, 3½″	100
.5	...	0	.03	.08	.2	0	270	1 sector, 3½″	122
.9	...	0	.00	.00	...	0	90	6 pretzels	25
.8	...	0	.24	.15	2.2	0	100	1 plain roll	32
.5	...	0	.08	.13	.8	0	100	1 sweet roll	32

MEAT, POULTRY

Constituents of 10

NAME	PROXIMATE COMPOSITION							MINERALS	
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbohydrates g.	Crude Fiber g.	Calcium mg.	Phosphorus mg.
BEEF									
Chuck roast	218	65.0	18.6	16.0	.9	.0	...	11	200
Corned beef, canned	232	57.3	24.4	15.0	3.4	.0	...	29	113
Dried or chipped beef	194	47.7	34.3	6.3	11.6	.0	...	20	370
Hamburger	316	55.0	16.0	28.0	...	.0	...	9	172
Loin steaks	293	57.0	16.9	25.0	.8	.0	...	10	182
Rib roast or steaks	277	59.0	17.4	23.0	.8	.0	...	10	188
Round steak	194	67.0	19.3	13.0	.9	.0	...	11	208
Rump roast	341	53.0	15.5	31.0	.8	.0	...	9	167
Soup meat, shank	162	70.0	20.3	9.0	.9	.0	...	12	219
Stew meat	333	53.0	15.8	30.0	.7	.0	...	9	170
LAMB									
Chops, rib	211	65.3	17.7	15.6	.9	.0	...	11	202
Leg roast	230	63.7	18.0	17.5	.9	.0	...	10	194
Shoulder roast	290	58.3	15.6	25.3	.8	.0	...	9	168
PORK									
Bacon, lean	626	20.0	9.1	65.0	4.3	1.1	...	13	108
Ham, fresh	340	53.0	15.2	31.0	.8	.0	...	9	164
Ham, smoked	384	42.0	16.9	35.0	5.4	.3	...	10	182
Loin	291	58.0	16.4	25.0	.9	.0	...	10	177
Picnic	347	52.0	14.8	32.0	.8	.0	...	9	160
Pork links, sausage	446	41.9	10.8	44.8	2.1	.0	...	6	116
Salt pork, fat	781	8.0	3.9	85.0	3.5	.0	...	2	42
Spareribs	346	53.0	14.6	32.0	.8	.0	...	8	157
VEAL									
Chops	176	69.0	19.2	11.0	1.0	.0	...	11	207
Cutlet	159	70.0	19.5	9.0	1.0	.0	...	11	210
Leg roast	186	68.0	19.1	12.2	1.0	.0	...	11	206
Stew meat	226	64.0	18.3	17.0	.9	.0	...	11	197
VARIETY MEATS AND MEAT MIXTURES									
Bologna	217	62.4	14.8	15.9	3.3	3.6	...	9	160
Brains, beef	127	77.9	10.5	8.8	1.4	1.4	...	8	380
Chili con carne without beans, canned	198	66.3	10.2	14.6	...	6.4	...	21	152
Frankfurters	201	64.3	15.2	14.1	3.1	3.3	...	9	164
Gelatin, dried	343	13.0	85.6	.1	1.3	.0	...	453	234
Hash, corned beef, canned	143	69.4	15.1	6.1	2.3	7.0	...	26	90
Heart, fresh beef	126	75.4	16.5	6.3	1.1	.7	...	10	236
Kidney, beef	136	74.9	15.0	8.1	1.1	.9	...	14	262
Liver, fresh, beef	131	70.9	19.8	4.2	1.4	3.6	...	8	373

ND SEAFOOD

ams of Edible Portion

MINERALS		VITAMINS					AVERAGE PORTION		
on mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in Grams
								BEEF	
.8	...	0	.12	.15	5.0	0	150	1 slice chuck roast	68
.0	...	0	.02	.19	2.7	0	100	1 piece corned beef	45
.1	...	0	.11	.22	3.7	0	110	4 slices dried beef	56
.4	...	0	.10	.13	4.3	0	150	1 hamburger cake	88
.5	.12	0	.10	.13	4.6	0	293	1 loin steak	100
.6	...	0	.11	.14	4.7	0	277	2 slices rib roast	100
.9	.08	0	.12	.15	5.2	0	220	1 piece round steak	113
.3	...	0	.10	.12	4.2	0	341	2 slices rump roast	100
.0	...	0	.13	.16	5.5	0	162	2-3 pieces soup meat	100
.4	...	0	.10	.12	4.3	0	333	3 pieces stew meat	100
								LAMB	
.6	.42	...	...	...	...	..	100	1 rib chop	46
.7	...	0	.21	.26	5.9	0	120	1 slice leg roast	52
.3	...	0	.18	.23	5.2	0	290	4 slices shoulder roast	100
								PORK	
.8	...	0	.42	.10	2.1	0	100	2-3 slices broiled bacon	17
.3	...	0	.96	.19	4.1	0	340	1 slice fresh ham	100
.5	...	0	.78	.19	3.8	0	384	1 slice smoked ham	100
.5	.09	0	1.04	.20	4.4	0	291	1 piece pork loin	100
.2	...	0	.94	.18	4.0	0	347	1 slice	100
.6	...	0	.22	.15	2.3	0	180	3 links cooked sausage	56
.6	...	0	.18	.04	.9	0	273	1 piece broiled salt pork	35
.2	...	0	.92	.18	3.9	0	415	5 pieces cooked spareribs	120
								VEAL	
.9	.25	0	.18	.27	6.3	0	110	1 medium chop	60
.9	...	0	.18	.28	6.4	0	250	1 slice cutlet	159
.9	...	0	.17	.27	6.3	0	120	1 slice leg roast	65
.7	...	0	.17	.26	6.0	0	110	2 slices stew meat	60
								VARIETY MEATS	
.2	...	0	.31	.30	3.0	0	100	1 slice bologna	43
.3	...	0	.25	.26	6.0	14	127	2 pieces beef brains	100
.7	...	160	.01	.10	2.1	0	...	Chili con carne	..
.3	...	0	.19	.23	2.4	0	80	1 frankfurter sausage	40
..	...	...	...	...	...	..	27	1 tbsp. dried gelatin	8
.3	...	0	.02	.13	2.4	0	143	½ cup hash	100
.2	...	0	.54	.90	6.8	14	94	2 slices cooked heart	75
.0	.11	750	.45	1.95	7.4	..	136	½ cup cubed kidney	100
.1	2.15	19200	.27	2.80	16.1	31	125	1 piece fried liver	94

MEAT, POULTRY, AN

Constituents of 10

NAME	PROXIMATE COMPOSITION							MINERALS	
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbo-hydrates g.	Crude Fiber g.	Calcium mg.	Phos-phorus mg.
VARIETY MEATS, *Continued*									
Liver, fresh, calf	136	70.8	19.0	4.9	1.3	4.0	...	11	205
Liver sausage	258	59.0	16.7	20.6	2.2	1.5	...	9	238
Luncheon meat, canned	270	56.3	15.2	22.5	...	1.7	...	21	170
Mince meat	216	...	5.3	6.4	...	34.4	...	19	73
Rabbit, domestic	175	67.9	20.8	10.2	1.1	.0	...	11	199
Sweetbreads, beef	344	54.0	11.8	33.0	1.1	.0	...	14	596
Tongue, beef, smoked	261	56.6	19.3	20.3	3.5	.3	...	31	229
POULTRY AND EGGS									
Chicken, boned, canned	175	67.1	21.8	9.8	2.4	.0	...	32	218
Chicken, roasters	194	66.0	20.2	12.6	1.0	.0	...	16	218
Duck	322	54.3	16.1	28.6	1.0	.0	...	9	172
Goose	366	49.7	15.9	33.6	.9	.0	...	9	176
Turkey, medium	262	58.3	20.1	20.2	1.0	.0	...	23	320
Egg yolk, fresh	355	49.4	16.3	31.9	1.7	.7	...	147	586
Egg white, fresh	46	87.7	10.8	.0	.6	.8	...	11	15
Eggs, whole, dried	593	2.0	48.2	43.3	...	2.6	...	187	800
Eggs, whole, fresh	158	74.0	12.8	11.5	1.0	.7	...	54	210
FISH AND SHELLFISH									
Bluefish	...	...	...	...	...	...	...	23	235
Clams	77	80.3	12.8	1.4	2.1	3.4	...	102	105
Cod	70	82.6	16.5	.4	1.2	.0	...	18	189
Crabs	81	80.0	16.1	1.6	1.7	.6	...	103	205
Fish, misc., medium fat	98	77.2	19.0	2.5	1.3	.0	...	21	218
Haddock	71	81.7	17.2	.2	1.2	.0	...	19	197
Halibut	134	75.4	23.5	4.5	1.0	.0	...	13	254
Herring	159	79.6	14.5	10.5	1.3	.0	...	101	272
Lobster	84	79.2	16.2	1.9	2.2	.5	...	62	283
Mackerel, canned	197	64.3	19.2	13.2	2.8	.4	.09	225	274
Oysters, solids and liquor	50	87.1	6.0	1.2	2.0	3.7	...	68	172
Salmon, canned	92	68.7	21.4	7.0	2.7	.1	.05	184	292
Sardines in oil	266	54.4	19.6	21.7	3.8	.5	.12	354	434
Sardines in tomato sauce	210	63.1	17.8	14.8	2.7	1.5	.20	381	168
Scallops	74	80.3	14.8	.1	1.4	3.4	...	115	338
Shrimp, canned, wet pack	68	78.6	15.0	.7	5.2	.4	.07	55	149
Shrimp, canned, dry pack	120	66.5	26.7	1.3	5.0	.4	.11	104	240
Tuna, canned, total contents	255	55.4	24.0	17.3	2.1	.9	.25	8	224
White fish	150	69.8	22.9	6.5	1.6	.0	...	150	263

*Calculated on drained solids.

EAFOOD, Continued

ams of Edible Portion

MINERALS		VITAMINS					AVERAGE PORTION		
ron mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in Grams
								VARIETY MEATS, *Continued*	
5.4	4.41	20500	.52	3.30	17.6	32	118	2 slices cooked liver	90
5.4	...	5750	.17	1.12	4.6	0	77	1 slice liver sausage	30
1.4	...	0	.29	.21	2.7	0	81	1 slice luncheon meat	30
1.5	...	160	.02	.09	...	3	...	Mince meat	...
1.9	.20	...	.03	.06	6.5	4	...	Rabbit, domestic	...
1.6	...	...	...	...	...	...	175	¾ cup steamed sweetbreads	100
3.0	...	...	.15	.23	4.0	0	100	4 slices boiled tongue	35
								POULTRY AND EGGS	
1.9	...	*trace*	.01	.15	3.7	2	88	¼ cup canned chicken	50
1.9	.27	*trace*	.11	.18	8.6	4	194	3 slices chicken	100
2.4	.41	...	.12	.40	7.9	8	322	3 slices cooked duck	100
2.0	.33	...	.14	...	...	13	...	.....	...
3.8	.20	*trace*	.12	.19	7.9	...	130	1 slice turkey	51
7.2	...	3210	.32	.52	...	0	56	1 egg yolk	16
.1	...	*trace*	*trace*	.22	...	0	13	1 egg white	28
8.7	...	4460	.35	1.23	.2	0	30	1 tbsp. dried whole egg	5
2.7	.23	1140	.12	.34	.1	0	66	1 whole fresh egg	47
								FISH AND SHELLFISH	
1.1	.23	...	.07	.07	4.2	2	100	1 piece bluefish	113
...	...	20	.02	.02	...	15	100	6 medium clams	130
.9	.47	...	.04	.05	2.3	2	80	1 piece steamed cod	115
2.3	1.58	...	.23	.15	...	13	68	½ cup crab meat	84
1.0	...	...	.07	.07	4.2	2	...	.....	...
.9	.04	0	.01	.12	1.4	...	71	1 piece haddock	100
.7	.23	440	.09	.18	6.0	...	134	1 piece halibut	100
1.5	.28	100	.04	.11	3.5	...	159	1 medium herring	100
.8	.73	...	.15	.18	...	...	50	1 medium lobster	60
1.9	...	...	...	.20*	7.82*	...	209	½ cup mackerel	106
7.1	3.73	210	.18	.23	1.2	...	63	5 medium oysters	125
.6	.08	250	.02	.16	7.81	...	104	½ cup salmon	113
3.5	.04	115*	.02*	.13*	5.0*	...	160	5 medium or 7 small, drained	60
4.1	...	...	.01	.25	5.0	...	223	1½ large sardines	106
3.0	...	0	...	.07	1.4	...	100	¾ cup scallops	135
2.2	.30	...	.01*	.03*	1.36*	...	44	10-12 medium shrimp	65
3.5	.30	...	.01	.03	2.23	...	78	10-12 medium shrimp	65
1.2	...	200	.04*	.14*	10.2*	...	255	½ cup drained tuna	100
.4	.19	...	...	.09	...	...	150	1 piece steamed whitefish	100

SUGAR AND

Constituents of 100

NAME	PROXIMATE COMPOSITION							MINERALS
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbohydrates g.	Crude Fiber g.	Calcium mg.
Candy bars, 5¢	498	4.4	9.2	25.3	...	59.6	...	80
Candies, bulk	492	3.0	8.2	22.5	...	64.2	...	65
Candies, packaged	476	5.8	5.0	21.1	...	66.97	...	72
Candies, peanut	577	...	11.3	22.2	...	60.5	...	84.2
Candies, penny	452	3.8	7.3	15.0	...	71.9	...	100
Chocolate, unsweetened	570	2.3	5.5	52.9	3.2	18.0	2.6	95*
Cocoa	329	4.3	9.0	18.8	5.2	31.0	4.8	160*
Honey, strained	319	20.0	.3	.0	.2	79.5	...	5
Jams, marmalade	288	28.0	.5	.3	.4	70.8	.6	12
Jellies	261	34.5	.2	.0	.3	65.0	.0	12
Maple sirup	256	34.0	...	...	.7	64.0	...	165
Molasses, cane	240	24.0	.0	.0	4.0	60.0	.0	273
Sirup, table blends	296	25.0	.0	.0	.5	74.0	.0	46
Sugar, brown	382	3.0	.0	.0	1.2	95.5	.0	76
Sugar, granulated	398	.5	.0	.0	.0	99.5	.0	0

*May not be available because of oxalic acid.

WEETS

ams of Edible Portion

MINERALS			VITAMINS					AVERAGE PORTION		
os-orus mg.	Iron mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in Grams
80	2.5	...	0	.05	.17	5.7	0	297	1 5¢ bar	60
51	2.5	...	0	.08	.07	2.12	0	297	5 pieces	60
58	2.8	...	0	.08	.12	3.98	0	286	5 pieces	60
87	2.5	...	0	.20	.26	8.24	0	350	1 5¢ bar	60
56	1.9	...	0	.11	.12	...	0	270	5 pieces	60
43	4-7*	2.67	0	*trace*	.24	1.1	0	160	1 square	28
09	7-11*	...	0	*trace*	.39	2.3	0	30	1 tbsp.	9
16	.9	.20	0	*trace*	.04	0.2	4	64	1 tbsp.	20
12	.3	...	10	.02	.02	0.2	6	100	1 tbsp.	35
12	.3	...	10	.02	.02	0.2	4	100	1 tbsp.	35
15	3.0	...	...	...	...	...	...	56	1 tbsp.	22
51	6.7	...	0	.08	.16	2.8	0	55	1 tbsp.	23
16	4.1	...	0	.00	.01	0.1	0	...	.....	..
37	2.6	...	0	.00	.00	.0	0	34	1 tbsp.	9
0	.1	.02	0	.00	.00	.0	0	52	1 tbsp.	13

A. JOHNSTON and A. COLLIER: *J. Am. Diet. Assoc.* **26**, 93 (1950).

VEGETABLES

Constituents of 10

NAME	PROXIMATE COMPOSITION							MINERALS	
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbo-hydrates g.	Crude Fiber g.	Calcium mg.	Phos-phorus mg.
ROOTS AND TUBERS									
Beet, fresh	46	87.6	1.6	.1	1.11	9.6	.9	27	43
Beet, canned	34	90.3	.9	.1	.80	7.4	.5	14	17
Carrot, fresh	45	88.2	1.2	.3	1.02	9.3	1.1	39	37
Carrot, canned	28	91.9	.7	.2	.91	5.8	.6	25	20
Parsnip	83	78.6	1.5	.5	1.15	18.2	2.2	57	80
Potato, sweet	125	68.5	1.8	.7	1.07	27.9	1.0	30	49
Potato, white	85	77.8	2.0	.1	.99	19.1	.4	11	56
Radish	22	93.6	1.2	.1	.95	4.2	.7	37	31
Rutabaga	41	89.1	1.1	.1	.83	8.9	1.3	55	41
Turnip	35	90.9	1.1	.2	.73	7.1	1.1	40	34
Yam	107	72.6	2.1	.2	.98	24.1	.8	8	41
LEAF AND STEM VEGETABLES									
Asparagus, fresh	26	93.0	2.2	.2	.67	3.9	.7	21	62
Asparagus, white canned	20	93.3	1.9	.3	1.46	2.7	.5	15	33
Asparagus, green canned	20	93.6	1.9	.3	1.26	2.5	.5	18	43
Beet greens	33	90.4	2.0	.3	1.70	5.6	1.4	118	45
Brussels sprouts	58	84.9	4.4	.5	1.28	8.9	1.3	34	78
Cabbage	29	92.4	1.4	.2	.75	5.3	1.0	46	31
Sauerkraut	21	92.4	1.0	.2	1.97	3.8	.7	36	18
Celery	22	93.7	1.3	.2	1.08	3.7	.7	50	40
Chard, leaves and stalks	25	91.8	1 4	.2	2.20	4.4	.9	105	36
Chicory, French endive	21	94.2	1 6	.3	1.00	2.9	.8	18	21
Chives	52	86.0	3.8	.6	1.80	7.8	2.0	48	57
Collards	50	86.6	3.9	.6	1.70	7.2	1.2	249	58
Dandelion greens	52	85.8	2.7	.7	2.00	8.8	1.8	187	70
Endive or Escarole	24	93.3	1.6	.2	.89	4.0	.8	104	38
Kale	50	86.6	3.9	.6	1.70	7.2	1.2	225	62
Kohlrabi	36	90.1	2.1	.1	1.05	6.7	1.1	74	44
Leek	45	88.2	2.5	.4	1.03	7.9	1.3	58	56
Lettuce, headed	18	94.8	1.2	.2	.91	2.9	.6	22	25
Mustard greens	28	92.2	2.3	.3	1.21	4.0	.8	220	38
Onion	49	87.5	1.4	.2	.58	10.3	.8	32	44
Parsley	60	83.9	3.7	1.0	2.40	9.0	1.8	290	55
Rhubarb	18	94.9	.5	.1	.72	3.8	.7	51	25
Spinach	25	92.7	2.3	.3	1.53	3.2	.6	81	55
Spinach, canned	21	93.0	2.0	.4	1.64	2.3	.7	85	26
Turnip greens	37	89.5	2.9	.4	1.76	5.4	1.2	259	50
Water cress	23	93.6	1.7	.3	1.09	3.3	.5	168	41
Mushrooms, common	12	91.1	2.4	.2	1.14	.0	.9	14	98
Mushrooms, canned	49	93.2	2.9	.1	1.63	1.5	.7	6	68

VEGETABLES

Grams of Edible Portion

MINERALS		VITAMINS					AVERAGE PORTION		
Iron mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in Grams
								ROOTS AND TUBERS	
1.0	.14	20	.03	.05	.4	10	50	½ cup diced, steamed	100
1.8	...	17	.01	.02	.1	4	38	½ cup diced beets	113
.8	.08	12000	.07	.06	.5	6	30	½ cup carrots	66
.7	...	12335	.02	.02	.3	2	32	½ cup diced carrots	113
.7	.12	0	.11	.09	.2	18	50	4 pieces steamed parsnips	83
.7	.15	7700	.10	.06	.7	22	200	1 medium, baked	162
.7	.17	20	.11	.04	.1	24	100	1 medium, boiled	120
1.0	.16	30	.04	.04	.1	24	22	10 red radishes	100
.4	.15	330	.06	.06	.5	36	50	½ cup steamed rutabaga	122
.5	...	*trace*	.06	.06	.5	28	25	½ cup diced, steamed	88
7.4	...	...	...	...	...	6	155	1 yam, pared	150
								LEAF AND STEM VEGETABLES	
.9	.14	1000	.16	.17	1.2	33	26	12 stalks, 5″ long	100
.9	...	50	.05	.06	.7	15	22	6 medium spears	108
1.7	...	52	.07	.09	.8	19	22	6 medium spears	108
3.2	.09	6700	.05	.17	.3	34	33	½ cup, steamed	100
1.3	.10	400	.11	.06	.3	94	58	7 sprouts, steamed	100
.5	...	80	.07	.06	.3	52	13	½ cup, shredded	43
6.9	...	50	.03	.04	.1	18	23	½ cup sauerkraut	108
.5	.01	0	.03	.04	.3	7	14	½ cup diced celery	62
4.0	...	2800	.06	.13	.2	38	30	½ cup steamed chard	100
.7	.14	10000	.05	.20	...	15	21	4 chicory leaves	100
8.4	...	500	.12	...	...	70	52	2 bunches chives	100
1.6	...	6870	.22	.20	.8	100	50	½ cup steamed collards	102
3.1	.15	13650	.19	.14	.8	36	30	½ cup, steamed	65
1.2	.09	3620	.06	.20	.4	13	11	½ head endive	45
2.2	...	7540	.12	.35	.8	115	30	½ cup steamed kale	65
.7	.14	...	.06	...	.3	60	25	½ cup kohlrabi	70
...	...	1000	.15	...	...	24	26	2 leek stalks	57
.5	.04	540	.06	.07	.2	8	10	3 large lettuce leaves	57
2.9	...	6460	.09	.20	.8	102	20	½ cup, steamed	65
.5	.08	50	.03	.02	.1	9	30	1 medium raw onion	62
3.2	...	5000	.08	.30	...	106	6	10 aver. parsley sprigs	10
.5	...	30	.01	...	.1	9	100	½ cup stewed rhubarb	111
3.0	...	9420	.12	.24	.7	36	20	½ cup steamed spinach	83
2.1	...	5500	.02	.10	.3	13	21	½ cup canned spinach	102
2.4	.09	9540	.10	.56	.8	136	30	½ cup, steamed	90
2.6	...	1900	.12	.22	...	54	23	1 bunch water cress	100
.7	1.79	0	.10	.42	6.4	5	12	7 mushrooms	100
.5	...	16	.02	.19	1.6	2	44	⅓ cup canned mushrooms	90

VEGETABLES

Constituents of 100

NAME	PROXIMATE COMPOSITION							MINERALS	
	Calories	Water g.	Protein g.	Fat g.	Ash g.	Total Carbo-hydrates g.	Crude Fiber g.	Calcium mg.	Phos-phorus mg.
FLOWER, FRUIT, AND SEED VEGETABLES									
Artichoke	63	83.7	2.9	.4	1.10	11.9	3.2	47	94
Beans:									
Lima, fresh	131	66.5	7.5	.8	1.71	23.5	1.5	63	158
Lima, canned	68	80.8	4.1	.3	1.42	12.3	1.3	26	67
Lima, dried	341	12.6	20.7	1.3	3.80	61.6	3.8	68	381
Common or kidney, dried	350	10.5	22.0	1.5	3.90	62.1	3.9	148	463
Navy or pea, baked with pork & molasses sauce	136	66.7	6.4	1.9	1.70	23.3	1.3	81	116
Navy or pea, baked in tomato sauce	112	70.1	5.7	.4	2.10	21.5	1.2	63	42
String, snap, fresh	42	88.9	2.4	.2	.77	7.7	.4	65	44
String, snap, green, canned	19	93.5	1.1	.1	1.23	3.5	.6	34	21
Soy, dried	351	7.5	34.9	18.1	4.70	12.0	5.0	227	586
Broccoli	37	89.9	3.3	.2	1.10	5.5	1.3	130	76
Cauliflower	31	91.7	2.4	.2	.85	4.9	.9	22	72
Corn, sweet, yellow, fresh	108	73.9	3.7	1.2	...	20.5	...	9	120
Corn, sweet, yellow, canned, whole kernel	75	80.4	1.9	.6	.96	15.6	.5	4	50
Corn, sweet, yellow, canned, cream style	92	76.2	2.1	.6	1.06	19.5	.5	3	57
Cucumber	14	96.1	.7	.1	.44	2.7	.5	10	21
Eggplant	28	92.7	1.1	.2	.54	5.5	.9	15	37
Lentil, dried split	348	12.2	24.0	1.2	2.20	60.4	1.7	48	423
Musk-melon, cantaloupe	23	94.0	.6	.2	.60	4.6	.6	17	16
Okra	39	89.8	1.8	.2	.84	7.4	1.0	82	62
Peas, fresh	101	74.3	6.7	.4	.92	17.7	2.2	22	122
Smooth, Alaska, canned	61	82.6	3.5	.3	1.14	11.1	1.5	20	66
Sweet, wrinkled varieties, canned	53	84.8	3.4	.4	1.07	9.0	1.4	19	58
Chick, dry	369	10.6	20.8	4.7	3.00	60.9	5.3	92	375
Dried, split	354	10.0	24.5	1.0	2.80	61.7	1.2	73	397
Peppers, garden	29	92.4	1.2	.2	.50	5.7	1.4	11	25
Pumpkin, fresh	36	90.5	1.2	.2	.82	7.3	1.3	21	44
Pumpkin, canned	38	90.2	1.0	.3	.60	7.9	1.2	20	36
Squash, summer	19	95.0	.6	.1	.44	3.9	.5	15	15
Squash, winter	44	88.6	1.5	.3	.83	8.8	1.4	19	28
Tomato	23	94.1	1.0	.3	.57	4.0	.6	11	27
Tomato, canned	22	93.8	1.0	.2	.75	4.0	.4	6	19
Tomato, ketchup	110	69.5	2.0	.4	3.60	24.5	.4	12	18
Tomato, puree	40	89.2	1.8	.5	1.30	7.2	.4	11	37
Watermelon	31	92.1	.5	.2	.27	6.9	.6	7	12

Continued

Grams of Edible Portion

MINERALS		VITAMINS					AVERAGE PORTION		
Iron mg.	Copper mg.	A I.U.	B_1 mg.	B_2 mg.	Nicotinic Acid mg.	C mg.	Total Calories	Measure	Weight in Grams
								FLOWER, FRUIT AND SEED VEGETABLES	
1.9	.31	390	.15	.03	...	11	63	1 heart, edible portion	100
2.3	...	280	.25	.14	.9	32	106	½ cup steamed limas	81
2.4	...	150	.03	.04	.5	7	77	½ cup canned limas	113
7.5	.86	0	.60	.24	2.1	2	150	½ cup steamed limas	111
10.3	.65	0	.60	.24	2.1	2	...	Common, or kidney, dried	...
2.8	.32	...	...	...	...	...	...	.....	...
1.7	.30	...	...	...	...	...	...	.....	...
1.1	.10	630	.08	.10	.6	19	28	½ cup steamed	67
1.2	...	30	.03	.04	.3	3	21	½ cup canned	108
8.0	...	110	1.14	.31	2.1	...	100	⅛ cup dried soy beans	29
1.3	1.37	3500	.09	.21	.9	118	20	½ cup steamed broccoli	57
1.1	.14	90	.10	.11	.6	69	25	¼ small head cauliflower	82
.5	...	390	.15	.14	1.4	12	100	½ cup steamed corn	97
.4	...	150	.02	.04	.8	5	85	½ cup canned corn	113
.6	...	...	.03	.05	.9	6	104	½ cup canned corn	113
.3	.06	0	.04	.09	.2	8	14	14 slices cucumber	100
.4	.10	30	.07	.06	.8	36	135	1 slice fried eggplant	55
7.2	...	...	.73	.20	2.4	...	104	½ cup cooked lentils	30
.4	.06	3420	.06	.04	.8	33	23	½ cup melon balls	100
.7	.12	740	.12	.10	.7	30	20	5 okra pods	53
1.9	...	680	.36	.18	2.1	26	65	½ cup steamed peas	60
1.7	...	460	.10	.05	.7	10	69	½ cup canned peas	113
1.5	...	450	.11	.06	1.0	10	60	½ cup canned peas	113
7.1	...	...	.35	.15	1.4	2	110	½ cup cooked chick peas	30
6.0	.17	370	.87	.29	3.0	2	106	½ cup cooked split peas	30
.4	.10	630	.07	.04	.4	120	20	1 pepper	69
.8	...	3400	.05	.08	.6	8	32	½ cup cooked pumpkin	90
.7	.03	3400	.02	.06	.5	0	47	½ cup canned pumpkin	125
.4	.08	260	.04	.05	1.1	17	18	½ cup, steamed, mashed	100
.6	...	4950	.05	.08	.6	8	38	1 cup, seeded, rind removed	100
.6	.06	1100	.06	.04	.6	23	32	1 medium tomato	146
.5	...	960	.05	.03	.7	17	24	½ cup canned tomato	108
.8	.49	1880	.09	.07	2.2	11	15	1 tbsp. tomato ketchup	14
1.1	...	1880	.09	.07	1.8	28	40	½ cup tomato puree	100
.2	.07	590	.05	.05	.2	6	44	1 slice watermelon	331

SCIENTIFIC ACTIVITIES OF H. J. HEINZ COMPANY

THE SCIENTIFIC activities of H. J. Heinz Company are centered in its Research and Quality Control Division. This organization is composed of more than fifty trained specialists, with about the same number of technical assistants. They strive to advance the art and science of food technology, both by their own efforts and by collaboration with scientists of allied industries and with investigators in universities and research organizations.

The combined results of these investigations are reflected in the quality of the finished products. Exact specifications for raw materials, the use of specially-designed equipment and the employment of processing methods best suited to produce foods of the highest merit are carefully studied and rigorously tested before final approval is given for their use by the Manufacturing Division.

The scientific staff of H. J. Heinz Company is organized into six major divisions:

A central quality control group responsible for establishing standards of quality for raw materials and finished products.

A local quality control group, operating in each factory, responsible for enforcing set standards of quality.

A scientific group concerned with the development of new food varieties and with the improvement of the quality and acceptability of the 57 varieties by chemical, microbiological and nutritional studies.

A research engineering group responsible for designing production equipment to take advantage of the most recent advances in technological development.

A new products group composed of experienced chefs and trained scientists, responsible for developing new products and improving recipes.

A raw products group responsible for selection and development of strains and hybrids, particularly suited for production of high quality fruits and vegetables. This group gives technical advice to growers supplying crops to Heinz factories.

Since 1921 H. J. Heinz Company has maintained a research fellowship at Mellon Institute. In addition to its long-range research activities, the Fellowship prepares NUTRITIONAL DATA (formerly "Nutritional Charts") and "Nutritional Observatory," a quarterly journal available upon request.

The company is a founder member of the Nutrition Foundation, which supports basic research and education in the science of nutrition. It is a member of the Associates, Quartermaster Food and Container Institute, Chicago, and contributes to the support of the Gordon Research Conferences of the American Association for the Advancement of Science. Close cooperation is maintained with state and Federal agricultural experiment stations and scientific laboratories. Other contacts are maintained with Federal and state food officials and with the Council on Foods and Nutrition of the American Medical Association.

USES OF HEINZ STRAINED FOODS

I. Baby Feeding—Infants from Three Months to Two Years

II. Soft Diets—When Indicated:

A. Difficulty in Chewing or Swallowing

Tooth extractions.
Broken jaws.
Tonsillectomies.
Infections; *i.e.*, Vincent's angina (trench mouth), severe septic sore throat, abscesses, quinsy and diphtheria.
Paralysis.
Obstruction of esophagus; *i.e.*, from tumors or stricture (as in lye burns).

Gavage—strained foods will pass freely through a tube, and may be used as a balanced source of nutrients in feeding by stomach tube.

B. Gastrointestinal Abnormalities

Gastric hyperacidity.
Gastric ulcer.
Gastric cancer.
Gastritis.
Pylorospasm.
Intestinal ulcer.
Enteritis (colitis)
Duodenitis.
Biliary tract diseases, cholecystitis.
Diverticulitis.
Colostomy.
Vomiting of pregnancy.
Cyclic vomiting.
Amebic dysentery.

C. Times when Burden on Digestive System Should Be Light

Convalescence from febrile conditions; *i.e.*, scarlet fever, diphtheria, measles, typhoid fever and undulant fever.
Convalescence after surgical operations.
Anorexia.
Exhaustion.
Various cardiac conditions.
Nervous indigestion, dyspepsia.

III. Convenience in Supplying Essential Nutrients When a Soft Diet is not Imperative

Invalids.
Convalescents.
Pernicious Anemia.
Nephritis.
Epilepsy.
Pregnancy.

IV. Geriatric Feeding

Many of the considerations under II and III above apply to the feeding of aged or senile individuals. In such instances, strained and/or junior foods may be used as a bland, palatable and interesting source of dietary essentials for the diet of the aged.

USES OF HEINZ JUNIOR FOODS

I. Feeding of Children Beyond the Strained Foods Age

To facilitate the transition from strained foods to table foods.

To furnish foods of high nutritive value.

To familiarize children with new flavors and textures.

II. For Older Children

To supply lightly seasoned foods of high nutritive value, particularly when the regular family diet is not suitable for children.

III. For Adults on Special Diets

Semi-soft diets—when the intake of coarse food must be restricted, but an absolutely smooth diet is not obligatory.

Simple foods, of good nutritive value, for convalescents, invalids and the aged.

COMPOSITION OF

Constituents

VARIETY	PROXIMATE COMPOSITION						
	Total Calories	Total Solids g.	Protein g.	Fat g.	Ash g.	Total Carbo-hydrates g.	Crude Fiber g.
STRAINED FOODS: *See pp. 104-107*							
JUNIOR FOODS: *See pp. 108-111*							
BAKED BEANS							
With pork and molasses sauce	136	33.3	6.4	1.9	1 7	23.3	1.3
With pork and tomato sauce	122	31.4	6.1	2.2	1.9	21.2	1.7
In tomato sauce	111	30.8	6.4	.5	1.9	21.9	1.9
CONDIMENTS AND PICKLES							
57-Sauce	111	31.8	2.6	1.8	5.5	21.9	.8
Chili Sauce	123	35.0	2.0	.0	4.3	28.7	.8
Chow-Chow Pickle	33	12.4	1.4	1.3	5.6	4.0	.6
Horse-Radish, dehydrated	374	96.5	15.6	.9	5.0	75.0	8.2
India Relish	138	35.8	.2	.8	2.1	32.6	.8
Mustard—Brown	113	22.9	5.2	7.5	3.9	6.3	1.1
Mustard—Yellow	101	23.2	4.7	4.6	3.8	10.2	1.1
Pickled Onions	10	7.1	.2	.2	4.8	1.9	.5
Dill Pickles	9	7.4	.7	...	4.2	1.5	.5
Fresh Cucumber Pickle	77	22.1	.8	.2	2.2	18.0	.5
Sour Pickles	14	7.3	.6	.1	3.9	2.6	.6
Sweet Mustard Pickle	122	31.1	1.5	.9	1.7	27.1	.9
Tomato Ketchup	132	37.4	2.3	.0	4.5	30.7	.7
Worcestershire Sauce	81	25.3	1.5	.0	5.1	18.7	...
DESSERTS							
Fig Pudding	343	70.6	4.5	14.6	1.8	49.5	1.1
Plum Pudding	334	66.8	3.9	15.7	2.1	44.7	.5
Mince Meat	228	53.0	2.9	4.9	1.3	43.5	.5

1. Determined as chloride by titration with $AgNO_3$, and calculated as NaCl.
2. N.S.A.—no salt added in manufacture.

HEINZ PRODUCTS

of 100 Grams

MINERALS					INGREDIENTS
Calcium mg.	Phosphorus mg.	Iron mg.	Copper mg.	Sodium Chloride[1] g.	
81	116	2.8	.32	.80	Beans, sugar, pork, molasses, salt, baking soda, spices.
69	46	1.1	.20	1.18	Beans, tomatoes, sugar, pork, salt, distilled vinegar, baking soda, onions, spices.
63	42	1.7	.30	1.04	Beans, tomatoes, sugar, salt, baking soda, distilled vinegar, onions, spices.
54	47	5.6	.90	4.50	Tomatoes, malt, distilled and cider vinegars, sugar, salt, spices, apples, onions, raisins, turmeric, tragacanth and lemons.
20	52	.1	.41	3.40	Tomatoes, sugar, distilled vinegar, salt, onions, spices.
32	53	2.6	.18	3.40	Pickles, malt and distilled vinegars, cauliflower, onions, salt, mustard, spices, alum, turmeric, tragacanth, lemons.
500	220	8.8	1.09	N.S.A.[2]	Horse-radish.
20	14	.8	.38	1.81	Pickles, vinegar, sugar, cabbage, onions, spices, peppers, salt, tamarinds, flavors, turmeric, onions.
103	126	1.8	.28	2.87	Distilled vinegar, mustard seed, salt, spices, turmeric.
67	70	2.0	.25	2.96	Distilled vinegar, mustard seed, sugar, salt, turmeric and spices.
20	6	2.0	.54	4.46	Onions, distilled vinegar, salt, chili pepper and spices.
35	18	1.9	.20	3.70	Pickles, salt, dillweed, vinegar, alum and spices.
33	24	1.5	.20	1.71	Cucumbers, distilled vinegar, sugar, salt, onions, spices and turmeric.
17	15	3.2	.26	3.44	Pickles, vinegar, salt, alum, spices, flavors and turmeric.
23	22	1.5	.32	1.34	Vinegar, pickles, sugar, cauliflower, onions, mustard, spices, salt, alum, flavors and turmeric.
24	54	.6	.25	3.20	Tomatoes, sugar, distilled vinegar, salt, onions and spices.
107	63	5.9	.43	3.77	Malt and cider vinegars, soy sauce, anchovies, garlic, tamarinds, sugar, salt, spices and flavors.
97	76	1.1	.16	.74	Sugar, figs, milk, suet, eggs, oat and wheat flours, baking powder, salt, vanilla extract and spices.
65	102	1.3	.30	.97	Milk, raisins, currants, suet, sugar, flour, rolled oats, eggs, citron, orange peel, salt, spices and baking soda.
37	35	1.8	.44	.74	Apples, sugar, raisins, currants, kidney suet, beef, vinegar, citron, lemon peel, salt, spices.

COMPOSITION OF

Constituents

VARIETY	PROXIMATE COMPOSITION						
	Calories	Total Solids g.	Protein g.	Fat g.	Ash g.	Total Carbohydrates g.	Crude Fiber g.
SOUPS—CONDENSED							
Bean with Smoked Pork	128	31.3	6.9	2.9	2.8	18.7	1.2
Beef Noodle	66	12.7	3.0	2.5	2.4	8.0	.1
Beef with Vegetables	61	15.0	4.1	2.3	2.7	5.9	.2
Chicken Noodle	70	14.6	2.3	4.1	2.4	5.9	.1
Chicken, Cream of	66	14.9	3.0	3.3	2.4	6.1	.1
Chicken with Rice	37	10.1	2.1	1.3	2.4	4.3	.04
Clam Chowder	66	17.6	2.2	1.6	3.0	10.8	.6
Green Pea, Cream of	69	17.3	2.9	2.0	2.4	9.9	.3
Gumbo Creole	66	15.4	1.2	2.9	2.4	8.7	.3
Mushroom, Cream of	100	21.3	3.5	5.2	2.9	9.6	.4

1. Determined as chloride by titration with $AgNO_3$, and calculated as NaCl.

HEINZ PRODUCTS

f 100 Grams

MINERALS					INGREDIENTS
Calcium mg.	Phos-phorus mg.	Iron mg.	Copper mg.	Sodium Chloride[1] g.	
93	125	2.2	.22	1.92	Water, beans, smoked pork, tomato puree, salt, carrots, sugar, vegetable oil, flour, beef extract, spices, flavoring.
10	47	1.3	.13	2.17	Beef stock, cooked beef, egg noodles, salt, onions, carrots, vegetable oil, monosodium glutamate, sugar, parsley, beef extract, flavoring.
12	70	.8	.10	2.19	Beef stock, cooked beef, barley, carrots, peas, salt, onions, celery, turnips, corn oil, beef extract, burnt sugar coloring, MSG, sugar, spices, flavoring.
16	25	.2	.05	2.25	Chicken broth, egg noodles, chicken, vegetable oil, salt, celery, onions, monosodium glutamate, spices and flavoring.
36	45	.1	.08	2.11	Chicken broth, flour, chicken, carrots, cream, vegetable oil, salt, celery, cornstarch, sugar, onions, monosodium glutamate, spices.
10	20	.1	.07	2.24	Chicken broth, rice, chicken, onions, salt, chicken fat, monosodium glutamate, flavoring, spices.
23	38	.5	.24	2.52	Potatoes, clams, tomato puree, carrots, onions, celery, pepper, salt, cream, sugar, corn oil, red peppers, flour, cornstarch, salt, monosodium glutamate, parsley, hydrolysed wheat protein, spices.
31	54	.9	.15	2.00	Peas, split peas, cream, sugar, salt, flour, celery, monosodium glutamate, spice, flavoring.
25	18	.7	.16	1.84	Tomato puree, okra, rice, celery, onions, butter, salt, green peppers, sugar, hydrolysed wheat protein, spices, monosodium glutamate, cornstarch, garlic, parsley, Worcestershire sauce.
100	95	.5	.04	2.15	Mushrooms, flour, vegetable oil, cream, whole milk powder, salt, tomato puree, cornstarch, MSG, hydrolysed wheat protein, sugar, flavoring, spice.

COMPOSITION OF HEINZ

Constituents

VARIETY	PROXIMATE COMPOSITION						
	Calories	Total Solids g.	Proteins g.	Fat g.	Ash g.	Total Carbo-hydrates g.	Crude Fiber g.
SOUPS—CONDENSED, *Continued*							
Tomato, Cream of	76	20.6	1.7	1.5	3.0	13.9	.3
Vegetable with Beef Stock	80	21.1	2.9	.9	2.0	15.1	.9
Vegetable without meat	82	22.7	2.9	.4	2.4	16.8	.8
OTHER VARIETIES							
Chile Con Carne	129	27.3	8.4	5.5	2.0	11.4	.9
Dry Egg Noodles	39	91.1	11.8	5.9	.6	72.7	.2
Macaroni in Cream Sauce	93	20.0	3.8	4.0	1.5	10.6	.1
Spaghetti in Tomato Sauce	90	21.6	2.1	2.2	1.8	15.5	.3
Dry Spaghetti or Macaroni	372	91.2	13.7	1.9	.7	74.9	.4
Jellies	277	69.8	.2	.1	.2	68.8	.0
Peanut Butter	623	98.6	25.2	48.9	3.9	20.6	3.1

1. Determined as chloride by titration with $AgNO_3$, and calculated as NaCl.
2. N.S.A.—no salt added in manufacture.

PRODUCTS, *Continued*

f 100 Grams

MINERALS					INGREDIENTS
Calcium *mg.*	Phos-phorus *mg.*	Iron *mg.*	Copper *mg.*	Sodium Chloride[1] *g.*	
22	33	.7	.07	2.39	Tomatoes, flour, sugar, salt, vegetable oil, cream, flavoring, baking soda.
24	43	.5	.10	1.38	Beef stock, tomato puree, carrots, potatoes, peas, corn, cabbage, onions, salt, semolina numerals, macaroni, green beans, sugar, navy beans, barley, lima beans, turnips, celery, sweet potatoes, cornstarch, red peppers, defatted milk solids, parsley, monosodium glutamate, beef extract, flavoring.
33	44	.5	.13	1.92	Tomato solids, carrots, potatoes, peas, lima beans, corn, sugar, pea beans, salt, green beans, green peppers, onions, corn oil, cornstarch, cabbage, celery, turnips, numerals, tubetti, hydrolysed wheat protein, monosodium glutamate, flavoring.
30	95	1.9	.19	1.35	Water, beef, pink beans, tomato puree, beef suet, flour, salt, chili peppers, onions, spices, sugar, garlic.
35	39	...	.17	N.S.A.[2]	Flour, egg yolks.
93	45	.1	.12	1.03	Cooked macaroni, milk, cheese, flour, salt, butter, spices.
16	28	.6	.13	1.38	Cooked spaghetti, tomato puree, sugar, carrots, onions, salt, butter, vegetable oil, cheese, peppers, flavoring, baking soda.
20	31	...	.11	*trace*	Semolina.
5	2	1.8	.46	N.S.A.	Fruit juice, sugar, pectin, citric acid.
105	76	...	.55	1.80	Virginia and Spanish peanuts, salt, hydrogenated peanut oil.

COMPOSITION AND NUTRITIVE

Constituents

VARIETY	PROXIMATE COMPOSITION							MINERALS
	Calories	Total Solids g.	Protein g.	Fat g.	Ash g.	Total Carbohydrates g.	Crude Fiber g.	Calcium mg.
JUICES								
Apple	44	11.8	0.1	0.1	.5	10.8	0.0	6
Apricot Nectar	52	13.9	0.3	0.1	.5	12.4	0.2	9
Grape Juice	72	18.8	0.3	0.2	.2	17.3	0.0	7
Grapefruit Juice	40	11.5	0.4	0.2	.4	9.2	0.0	8
Orange and Grapefruit Juice	41	11.8	0.5	0.1	.4	9.6	0.0	9
Orange Juice	43	12.0	0.7	0.2	.5	9.7	0.0	8
Prune Juice	76	19.7	0.4	0.1	.6	18.3	0.0	18
Tomato Juice[2]	23	7.3	0.7	0.0	1.2	5.0	0.2	6

1. No salt added to these products. Bills (*J. Am. Diet. Assoc.* **25**, 304 [1949]) reports the sodium content of fruit juices (in mg. of sodium per 100 g.) as: apple 4; apricot 2; grape juice 1; grapefruit juice 0.4; orange juice 0.4; prune juice 2.
2. Sodium chloride content: 0.74 g. per 100 g.

JUICES

ALUE OF HEINZ PRODUCTS

f 100 Grams

MINERALS			VITAMINS					INGREDIENTS
Phos-phorus mg.	Iron mg.	Copper mg.	A I.U.	Thiamine mcg.	Riboflavin mcg.	Nicotinic Acid mg.	C mg.	
9	10.1	.14	0	3	8	.07	1.4	Apples.
13	3.3	.13	1750	7	6	.26	1.1	Apricots, water, sugar.
10	.2	.17	0	14	10	.18	0	Concord grapes.
15	.1	.13	0	46	8	.13	29.3	Grapefruit, sugar, dextrose.
16	.1	.06	69	56	10	.15	32.9	Oranges, grapefruit, sugar, dextrose.
21	.1	.06	174	79	21	.21	47.3	Oranges.
21	3.4	.07	0	6	12	.46	.4	An aqueous infusion of dried prunes.
25	.1	.24	1400	59	29	.75	22.5	Tomatoes, salt.

NUTRITIVE VALUE OF
STRAINED FOODS

Constituents

VARIETY	PROXIMATE COMPOSITION							MINERALS	
	Calories	Total Solids g.	Protein g.	Fat g.	Ash g.	Total Carbo-hydrates g.	Crude Fiber g.	Calcium mg.	Phos-phorus mg.
FRUITS									
Apricots with Oatmeal	102	25.8	.9	.3	.4	23.8	.6	10	22
Apple Sauce	55	13.9	.2	.0	.2	13.5	.7	4	3
Apricots and Apple Sauce	67	17.2	.5	.2	.6	15.9	.6	14	20
Peaches	87	22.3	.4	.2	.2	21.0	.5	7	14
Pears and Pineapple	53	13.3	.3	.1	.2	12.7	.9	11	10
Plums with Farina	111	27.8	.8	.7	.4	25.3	.2	11	16
Prunes	122	31.0	1.1	.2	.7	29.0	.8	33	32
MEAT FOOD PRODUCTS									
Beef Broth with Beef and Barley	59	13.5	2.5	1.6	.9	8.6	.3	21	39
Beef and Liver Soup	66	14.5	4.4	2.3	.9	6.8	.3	21	40
Chicken Soup	59	11.6	2.4	3.3	1.1	4.9	.2	27	42
Vegetables and Bacon with Cereal	61	12.4	1.3	3.0	1.1	7.1	.4	12	20
Vegetables and Beef	54	13.7	3.4	1.2	1.3	7.9	.6	16	63
Vegetables and Lamb with Milk and Cereal	51	11.8	2.1	1.4	.9	7.6	.5	18	23

1. Determined as chloride by titration with $AgNO_3$, and calculated as NaCl
2. N.S.A.—no salt added in manufacture.

HEINZ BABY FOODS
FOR YOUNG BABIES
of 100 Grams

MINERALS			VITAMINS						INGREDIENTS
Iron mg.	Copper mg.	Sodium Chloride[1] g.	A I.U.	Thiamine B_1 mcg.	Ribo-flavin B_2 mcg.	Nicotinic Acid mg.	C mg.	Folic Acid mcg.	
.5	.11	N.S.A.[2]	2830	50	26	.35	.3	. . .	Apricots, oatmeal, sugar.
.2	.20	N.S.A.	0	13	13	.06	1.3	.4	Apples, sugar.
.6	.05	N.S.A.	2810	16	12	.34	1.4	.6	Apricots, apples, sugar.
.3	.06	N.S.A.	1035	10	25	.95	.8	.5	Peaches, sugar.
.5	.10	N.S.A.	5	19	23	.20	.7	. . .	Pears, pineapple, sugar, lemon juice.
.7	.08	N.S.A.	1300	19	15	.32	.3	. . .	Plums, sugar, farina.
1.8	.16	N.S.A.	1900	50	32	.87	1.2	1.1	Prunes, lemon juice.
.8	.15	.48	30	35	45	1.20	.5	1.7	Beef broth, beef, barley, beef extract and salt.
2.2	.18	.48	1830	23	75	1.70	2.5	2.0	Beef broth, carrots, beef, potatoes, tomato puree, celery, chicken and beef livers, farina and salt.
.1	.09	.92	290	75	90	.60	.5	1.4	Chicken broth, milk, farina, wheat germ, yeast, chicken meat, salt, celery, parsley.
.3	.06	.88	2640	128	57	.50	.6	. . .	Carrots, potatoes, celery, bacon, tomato puree, onions, wheat flour, farina, salt, yeast.
.3	.08	.79	2542	60	79	1.51	.9	. . .	Beef broth, carrots, beef, farina, potatoes, barley, celery, onions, tomato puree, yeast, salt, beef extract, monosodium glutamate.
.4	.10	.58	2100	12	36	.55	1.0	.7	Lamb broth, carrots, celery, milk, lamb, potatoes, onions, rice, cornstarch and salt.

NUTRITIVE VALUE OF HEINZ

STRAINED FOODS

Constituents

VARIETY	PROXIMATE COMPOSITION							MINERALS	
	Calories	Total Solids g.	Protein g.	Fat g.	Ash g.	Total Carbo-hydrates g.	Crude Fiber g.	Calcium mg.	Phos-phorus mg.
VEGETABLES									
Beets	43	11.4	1.5	0.1	0.7	9.1	0.6	17	37
Carrots	32	8.5	.8	0.2	0.8	6.7	0.7	33	35
Green Beans	28	7.4	1.2	0.4	0.7	5.0	0.8	40	20
Peas	60	15.4	4.4	0.2	0.7	10.1	0.7	19	89
Spinach	22	6.6	2.0	0.2	1.4	3.0	0.7	88	53
Squash	28	8.4	.8	0.1	1.1	6.1	0.7	29	37
Tomato Soup	58	15.7	2.3	0.1	1.3	12.0	0.8	22	39
Vegetable Soup	44	11.7	1.8	0.1	0.7	9.1	0.4	26	25
PUDDINGS									
Custard Pudding	102	23.6	3.0	2.3	0.8	17.4	0.0	81	61
Orange Pudding	103	24.9	1.7	1.4	0.7	21.0	0.05	36	39

1. Determined as chloride by titration with $AgNO_3$, and calculated as NaCl.
2. N.S.A.—no salt added in manufacture.

ABY FOODS, *Continued*

OR YOUNG BABIES

100 Grams

MINERALS			VITAMINS						INGREDIENTS
Iron mg.	Copper mg.	Sodium Chloride[1] g.	A I.U.	Thiamine B_1 mcg.	Ribo-flavin B_2 mcg.	Nicotinic Acid mg.	C mg.	Folic Acid mcg.	
1.6	.19	N.S.A.[2]	0	21	26	.11	1.0	9.1	Beets.
.2	.10	.30	15200	23	49	.59	.7	2.0	Carrots, salt.
.5	.11	.26	450	25	80	.37	3.7	1.6	Green beans, salt.
1.4	.19	.26	580	110	90	1.50	7.3	2.5	Peas, salt.
.9	.07	.28	5600	13	160	.50	15.4	5.1	Spinach, salt.
.3	.08	.54	2010	8	26	.26	1.2	...	Squash, salt.
.9	.21	.48	2500	49	60	.85	3.0	3.4	Tomatoes, sugar, carrots, potatoes, wheat flour, celery, wheat germ, whey powder, rice, salt.
1.0	.10	.20	5700	152	68	1.08	1.8	1.4	Carrots, celery, tomatoes, onions, potatoes, barley, rice, salt, and dried yeast.
.0	.05	.43	55	16	92	.79	1.5	.3	Sugar, whole milk powder, eggs, rice, cream, corn-starch, salt, vanilla.
.5	.12	.38	55	20	86	.15	3.6	.8	Orange juice, sugar, rice, eggs, whole milk powder, cornstarch, lemon juice, salt and vanilla.

NUTRITIVE VALUE OF

JUNIOR FOODS FOR

Constituents

VARIETY	PROXIMATE COMPOSITION							MINERALS	
	Calories	Total Solids g.	Protein g.	Fat g.	Ash g.	Total Carbo-hydrates g.	Crude Fiber g.	Calcium mg.	Phos-phorus mg.
FRUITS									
Apple Sauce	62	15.8	.2	.3	.2	14.7	.6	6	6
Apricots and Apple Sauce	67	17.7	.6	.2	.6	15.7	.6	15	21
Peaches	83	21.1	.6	.4	.4	19.3	.5	11	17
MEAT FOOD PRODUCTS									
Chicken Farina Vegetable Porridge	48	12.4	2.9	.6	1.3	7.7	.5	43	72
Chopped Vegetables and Beef	49	13.2	3.1	.4	1.4	8.3	.3	11	4
Chopped Vegetables and Bacon with Cereal	67	13.0	1.3	3.7	1.0	7.0	.3	18	21
Vegetables with Lamb and Liver	63	14.8	3.1	1.6	1.2	9.0	.2	44	59
VEGETABLES									
Chopped Beets	32	9.3	1.0	.1	.6	7.4	.5	38	15
Chopped Carrots	25	6.9	.9	.1	.8	5.2	.7	38	21
Chopped Green Beans	29	8.3	1.3	.2	1.2	5.4	.9	34	25
Chopped Mixed Vegetables	37	10.2	.8	.1	1.1	8.3	.5	30	26

1. Determined as chloride by titration with $AgNO_3$, and calculated as NaCl.
2. N.S.A.—no salt added in manufacture.

HEINZ BABY FOODS

OLDER BABIES

of 100 Grams

MINERALS			VITAMINS					INGREDIENTS
Iron mg.	Copper mg.	Sodium Chloride[1] g.	A I.U.	Thiamine mcg.	Ribo-flavin mcg.	Nicotinic Acid mg.	C mg.	
.4	.06	N.S.A.[2]	29	9	8	.05	1.5	Apples, sugar.
.8	.08	N.S.A.	1920	14	16	.37	1.5	Apricots, apples, sugar.
.1	.14	N.S.A.	960	8	21	.97	0.7	Peaches, sugar.
2.3	.36	.82	200	336	160	1.58	.8	Chicken broth, milk, farina, wheat germ, chicken meat, dried yeast, carrots, onions, celery, salt, chicken fat, parsley.
.1	.11	1.01	2500	19	39	.91	1.3	Water, carrots, beef, peas, onions, wheat flour, barley, potatoes, salt, celery, beef extract, parsley.
.1	.05	.76	2300	133	61	.59	1.4	Water, potatoes, carrots, bacon, tomato puree, onions, celery, wheat flour, peas, rice, salt, brewer's yeast, parsley.
.8	.38	.79	2600	27	180	1.55	3.2	Stock made with lamb and liver, milk, celery, potatoes, cooked lamb, cream, carrots, rice, farina, cooked lamb liver, onions, corn-starch, cooked chicken liver, salt.
.4	.21	N.S.A.	30	11	20	.09	4.8	Beets.
1.5	.04	.39	4000	36	58	.20	3.1	Carrots, salt.
.5	.40	.71	650	38	81	.51	3.0	Green beans, salt.
5.4	.04	.67	4680	16	23	.50	2.6	Carrots, sweet potatoes, potatoes, celery, green beans, onions, salt.

NUTRITIVE VALUE OF HEINZ
JUNIOR FOODS FOR
Constituents

VARIETY	PROXIMATE COMPOSITION							MINERALS	
	Calories	Total Solids g.	Protein g.	Fat g.	Ash g.	Total Carbo-hydrates g.	Crude Fiber g.	Calcium mg.	Phos-phorus mg.
VEGETABLES, *Continued*									
Chopped Spinach	19	5.5	1.8	.2	1.1	2.4	.7	174	35
Creamed Diced Vegetables	56	13.9	2.1	1.2	1.5	9.1	.3	99	61
Creamed Tomato and Rice	76	18.0	2.1	2.2	1.7	12.0	.6	32	44
PUDDINGS									
Pineapple Rice Pudding	99	23.6	1.4	1.6	.7	19.8	.2	39	35
Prune Pudding	122	30.4	2.0	.9	1.0	26.6	1.4	69	54
CEREALS FOR INFANTS									
Cereal, Pre-cooked	379	95.0	14.9	3.7	4.7	71.1	1.5	720	660
Oatmeal, Pre-cooked	380	94.0	16.8	5.5	6.0	65.8	1.9	1040	780

1. Determined as chloride by titration with $AgNO_3$, and calculated as NaCl.

BABY FOODS, *Continued*

OLDER BABIES

f 100 Grams

MINERALS			VITAMINS					INGREDIENTS
Iron *mg.*	Copper *mg.*	Sodium Chloride[1] *g.*	A *I.U.*	Thiamine *mcg.*	Ribo-flavin *mcg.*	Nicotinic Acid *mg.*	C *mg.*	
2.3	.08	.49	4500	33	200	.41	7.8	Spinach, salt.
1.2	.11	.95	1150	21	140	1.30	3.1	Celery, carrots, potatoes, cream, rice, tomatoes, onions, de-fatted milk solids, salt, sugar, flour, autolized yeast concentrate.
1.7	.66	.98	2150	46	45	.86	5.6	Tomatoes, carrots, potatoes, cream, celery, rice, corn syrup, sugar, milk, whey powder, soy bean flour, salt.
.2	.15	.39	38	27	70	.18	.8	Pineapple, sugar, rice, eggs, cream, de-fatted milk solids, starch, salt.
1.1	.16	.50	300	30	180	.31	.6	Milk, prunes, corn syrup, sugar, farina, eggs, starch, salt.
38.0	.80	1.18	....	2600	1100	26.00	...	Wheat, whole wheat, semolina, de-fatted wheat germ, oats, corn (cornmeal and de-fatted corn germ), de-fatted milk solids, sugar, dried yeast, calcium carbonate, salt, dicalcium phosphate, iron salt, nicotinic acid, thiamine hydrochloride and riboflavin.
37.0	.85	1.58	....	1230	880	22.80	...	Oats, de-fatted milk solids, sugar, salt, dicalcium phosphate, calcium carbonate, iron salt, nicotinic acid, thiamine hydrochloride, riboflavin.

SUGGESTIONS FOR FURTHER READING

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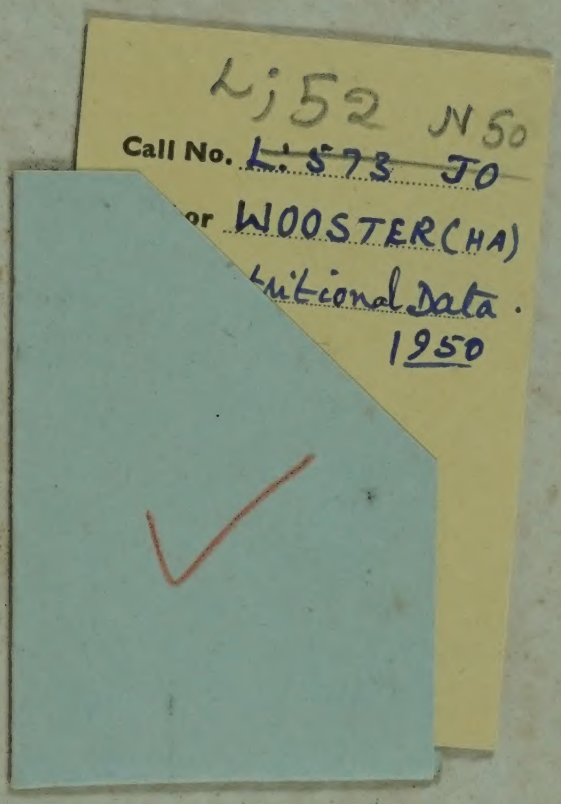
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